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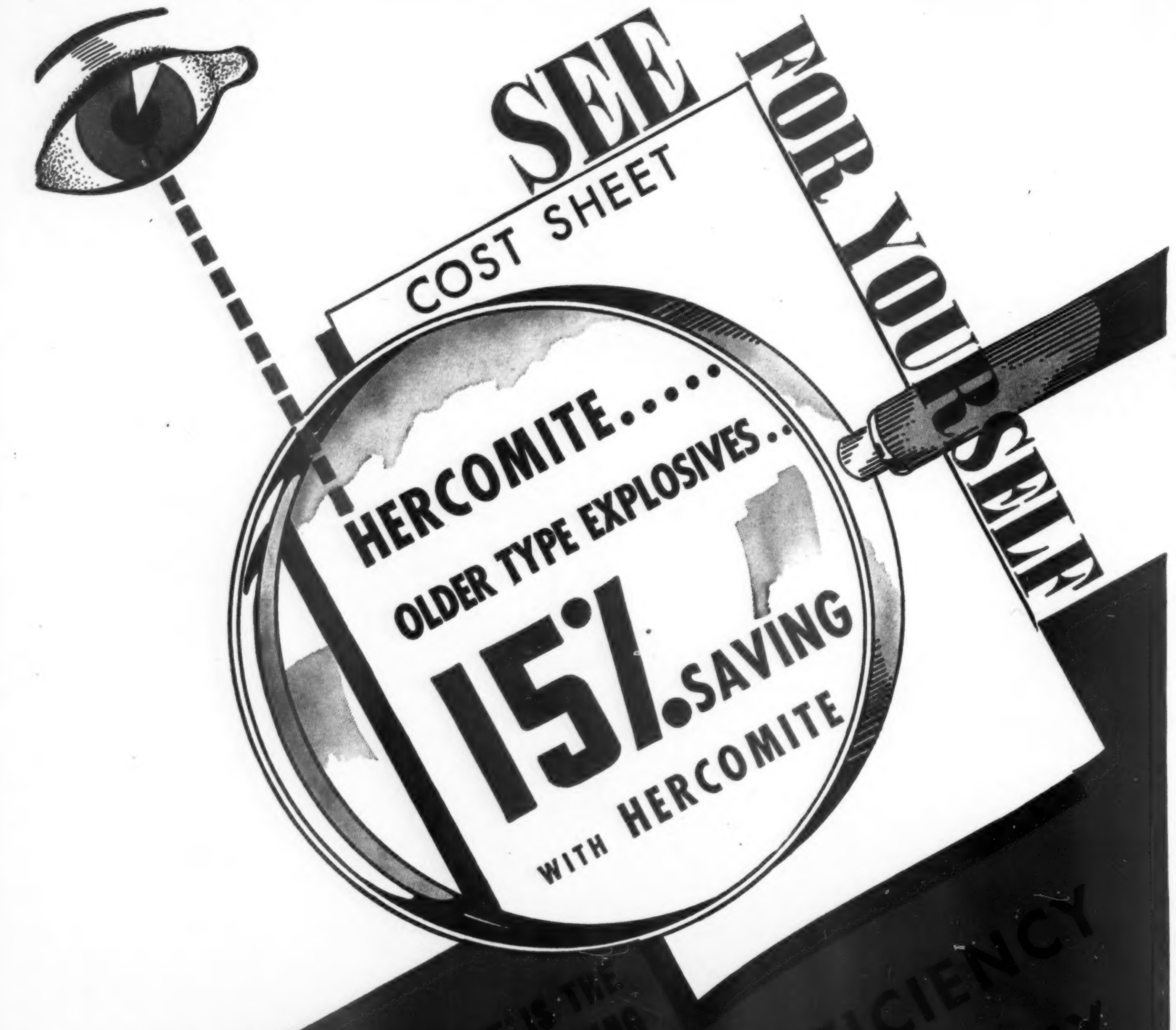
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ON THE COVER

THE cover picture shows a primitive method of hauling in a picturesque, mountainous region in Cape Province, South Africa. Albert Pass appears in the distance.

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IN THIS ISSUE

DURING 1938, the magazine *Steel* mentioned in its department *Behind the Scenes* that Bird & Sons, Inc., of East Walpole, Mass., was 144 years old and asked its readers if they knew of an older firm in the country. Some did and sent in the names. In the end, it was determined that the Taylor-Wharton Iron & Steel Company antedated any other industrial concern that is still in business. At the time it seemed to us that there must be an interesting story in such a company, and we took steps to get it. The result is the article that starts on page 6049. In our opinion, one of the most remarkable things about Taylor-Wharton is that its principal offices and works are still located at High Bridge, N. J., within a stone's throw of the original forge that began operating back in 1742.

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WE HAVE published several articles on metal spraying, and the inquiries that have followed each one have indicated that that process is not so well known in industry as we had supposed. Our current article describes a new type of gun, developed abroad, that makes use of both metallic and non-metallic materials in powdered form.

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MOST of us can remember when automobile tires had a very short life. The tread wore away fast; but, even so, few tires remained intact long enough for the tread to be reduced very much. The structure was weak and blowouts were common. Once the tread was worn thin, however, there was little that could be done for it. Times have changed now, and tires are made sound enough structurally to stand retreading, or recapping. How these rehabilitating processes are carried out is described in *Making Old Tires Like New* by Henry W. Young.

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A SHORT article describes a natural-gasoline plant of the Skelly Oil Company in the Eunice Field of New Mexico.

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ADVERTISING INDEX

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The Country's Oldest Industrial Concern

C. H. Vivian

REMAINS OF EARLY WORKS

It is of record that iron ore was being mined and reduced along the South Branch of the Raritan River in 1742, and some investigators believe that the first workings were established there as early as 1700. Scattered evidences of these pioneer activities are visible today. At the left is the remnant of a wall that stands within a few hundred feet of the present Taylor-Wharton plant at High Bridge, N. J. Faintly discernible in the picture just above are the remains of a slitting mill that was built about 1752. In it bars of iron, formed in a forge a short distance downstream, were cut into smaller sections. The stream furnished the power required for operating the various works. It is still used to run a turbine that drives a 350-kw. generator that supplies some of the power requirements of the present plant. The view at the upper left shows what is left of a blast furnace on Beaver Brook and about two miles from High Bridge.

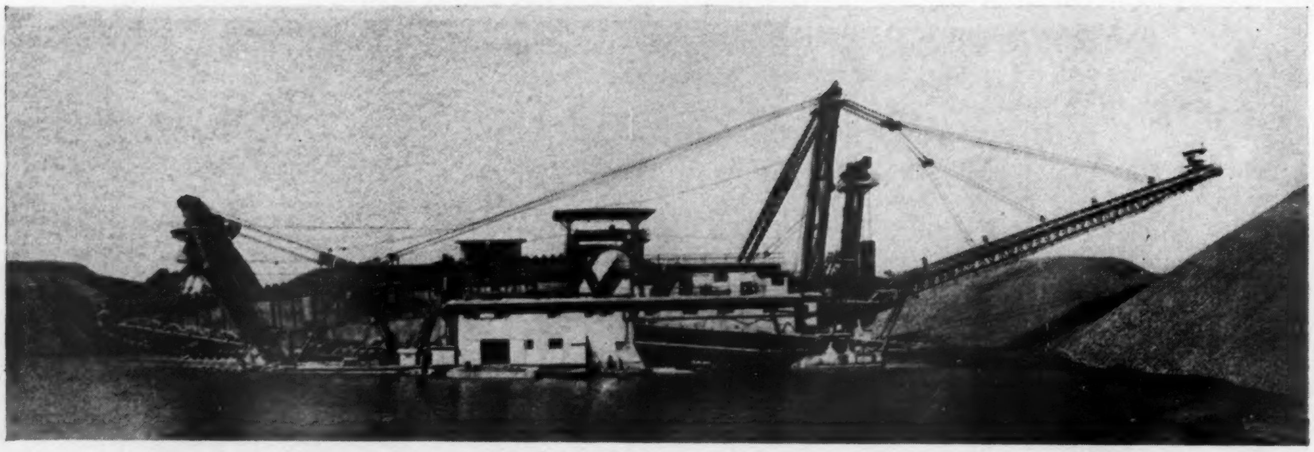
SOLITUDE, AND PRESENT OFFICE ENTRANCE

The mansion at old Union Forge was occupied by Robert Taylor, who managed the operations for Allen and Taylor and subsequently purchased them. During the Revolutionary War, John Penn and Benjamin Chew, prominent Tories, were paroled in Taylor's custody and lived in the mansion with him. It was Penn that gave the name Solitude to the setting. The structure in the foreground (upper left) was the original barn which has been made over into an attractive dwelling. Three of the Taylors that succeeded Robert Taylor in the management of the iron works lived in Solitude. The large house is completely furnished, but now unoccupied. At the left is shown an old fireplace in the house. On a plate in it is a date that seems to be 1764. The portrait is of L. H. Taylor, grandson of Robert. He died in High Bridge in 1907 at the age of 97 after directing the works there for many years. In the picture immediately above are, left to right: Charles B. Andrews, assistant to the president; George R. Hanks, president; and J. A. Krugler, general sales manager. They are standing at the entrance to the main offices at High Bridge. The steps and doorway were built a few years ago; but the structure itself is so old that records do not disclose its age.

IN OCTOBER 1942 the Taylor-Wharton Iron & Steel Company of High Bridge, N. J., will celebrate its two hundredth anniversary. So far as is known, it is the oldest industrial organization in the United States. It is also believed to be the second oldest concern on the North American continent, the oldest being the Hudson's Bay Company, which is now well on the way to completing its third century of existence. The Taylor-Wharton Iron & Steel Company has evolved from the Union Iron Works, which started operations in 1742 on the South Branch of the Raritan River only a short distance away from the principal manufacturing plant and head offices of the present Taylor-Wharton enterprise. This location is approximately 54 miles west of New York City.

The history of the iron-working industry in this area begins with the arrival in the colonies about 1686 of Daniel Coxe, a British doctor who is said to have been the personal physician of Queen Anne of England. Within a few years after reaching these shores, Coxe had purchased between 500,000 and 600,000 acres in West New Jersey—his holdings comprising nearly one-fifth of the province. These lands were assigned to the West New Jersey Society, a group of some 50 men that was organized by Coxe. At the same time, on March 4, 1691, Coxe invested the society with the authority to govern this tract. In 1702, however, the prerogative of government was surrendered to Queen Anne.

Despite this ownership of what later came to be known as "the society's great tract in Hunterdon County," squatters settled on various isolated portions of it, and one of these is supposed to have set up the first iron works along the South Branch of the Raritan. Just when this was done is not known, but some investigators have placed the date as early as 1700. It is of record, however, that by 1742 ore was being mined within the present limits of the Borough of High Bridge and that iron was being produced from it by the bloomery process, which was then probably known to only a few people in the colonies. A bloomery was essentially an enlarged blacksmith's forge. After the hearth had been well heated by burning charcoal in it for four or five hours, the fuel bed was heaped against the air-inlet side, with its top surface sloping downward toward the opposite side. Upon this burning charcoal were spread alternating layers of ore, limestone flux, and fresh charcoal. The air blast was then applied through a tuyere, its source probably being a bellows operated by hand or by water power. The charge of iron was slowly worked with a bar so that the air would penetrate all parts of it. Gradually the ore was reduced to a semi-metallic spongy mass of iron, and this was lifted out and hammered to expel some of the foreign matter from it. The hammer was a block of iron weighing from 400 to 600 pounds and fastened to one end of a long beam that was supported at its center. The opposite end of the beam engaged cams on the circumference of a revolving wheel driven by water power. In this manner, the hammer was alternately lifted and allowed to fall by



A MODERN GOLD DREDGE

The bucket-line dredge shown here belongs to Yuba Consolidated Goldfields and is in service near Hammonton, Calif. Buckets arranged in an endless chain, constituting the ladder, scoop up the gravel and carry it into the hull, where the metal is extracted. The tailings are conveyed to the rear and piled by a stacker. The hull is 233¾ feet long, 68 feet wide, and 11½ feet deep. The ladder is 200 feet long, the stacker 250 feet long, and the over-all length between their extremities is 510 feet. There are 126 buckets, each with a capacity of 18 cubic feet. The bucket line weighs 230 tons, and the entire dredge 3,500 tons. This dredge can dig 115 feet below the water line and work a maximum bank height of 30 feet, giving it a total vertical working range of 145 feet. Although they are best known in the United States in connection with gold mining, similar dredges, with modifications in their mineral-saving equipment, are used in even larger numbers throughout the world for recovering tin and to a smaller extent in platinum mining. There are 184 dredges in the Federated Malay States and other parts of the Far East. The buckets, and much of the mechanism that drives them, are made of manganese steel; and these products represent one of the principal Taylor-Wharton lines of business. The buckets of the first gold dredges used in California in 1898 were built entirely of plate steel and had a capacity of only 1½ cubic yards. A few years later, larger buckets of 3-piece construction were designed. The all-manganese bucket was first employed in California about 1911. The dredge shown here was built by the Yuba Manufacturing Company.

gravity upon an anvil. This device was called a tilt hammer. Usually the partially formed mass was placed in another forge, softened, and hammered a second time. The product was wrought iron and was generally marketed in the form of long bars of square section. These were used by local blacksmiths to fashion nails, shoes for draft animals, and parts for wagons and the crude farming implements then available.

Two of the influential men of Philadelphia at that time were William Allen and Joseph Turner. Although only 38 years old, Allen had been mayor of the city, a member of the common council and a member of the assembly of the province. He had studied law in London, and he and Turner had accumulated considerable money in a mercantile business that had been passed down by Allen's father. With the funds at their disposal, the two men began to buy up land and to interest themselves in the infant iron-working industry. Their first investment was at Durham, along the Delaware River, below Easton, Pa., where the production of iron was responsible for the creation of a distinctive type of "Durham" boat which was used for many years to transport iron and produce down the river to Philadelphia. The property on the South Branch of the Raritan came to the notice of these two men, and they apparently attempted, without success, to buy it. But, aware of other iron deposits in the area, or suspecting their existence, they leased 3,000 acres adjoining the established works. Their leasehold took in two miles of the main stream and more than that length of a tributary, Spruce Run. The lease specified the right to search for iron, tin, lead, and copper, and to erect furnaces and forges for the production of metals. Allen and Turner in 1742 built a furnace on Spruce Run nearly two miles from the old bloomery forge, and it was the business that was then started which persists today as the Taylor-Wharton Iron & Steel Company.

In some unrecorded manner, the West New Jersey Society regained possession of the original mine and forge about 1752 and sold them, together with a large acreage around them, to Allen and Turner. The purchase included the land previously leased and aggregated 10,849 acres. Thereupon began a short period of comparative prosperity for the iron workings. The furnace on Spruce Run produced pig iron, and it was made into bar iron at the old forge which had meanwhile been supplied with a wooden bellows imported from Germany. With these facilities it was possible to make a ton of bar iron from 2,600 pounds of pig iron, and this was considered a remarkable accomplishment in those days. A short distance from the forge there was erected a slitting mill for reducing the iron bars to smaller ones suitable for the use of farmside blacksmith shops. It is probable that nails were also made there. There is a record of a blast in 1761 from September 1 to December 1, during which time the furnace produced 332 tons of pig iron, with a notation that this exceeded the owners' most optimistic expectations. During this period, Allen wrote: "Water and wood we can never want." This was a prophetic error, for after the Revolutionary War, wood for charcoal became very scarce, so much so in fact that operations were conducted on a limited scale until anthracite coal became available from the Pennsylvania fields.

Allen built a large home near the furnace in Spruce Run, where he entertained his friends from Philadelphia, some 65 miles away. A general store was established to supply the needs of farmers, who spent their winters cutting wood to make the huge quantities of charcoal that were consumed. This settlement became known as Union Furnace and the home as Union Farm, while the forge in the valley of the Raritan was called Union Forge.

Allen and Turner bought a newly discovered iron mine in Essex County, 30 miles distant, and called it Andover. The ore was transported, first by pack animals and later in carts, to Union Furnace. In 1760, parliament prohibited the exportation of iron from the colonies, and the industry declined. Bemoaning this, Allen wrote, in 1765, that "we could make 500 tons of iron a year and the body of ore is so large as never to be exhausted"—another unwarranted estimate.

Numerous letters and records left by Allen shed much light on life as it was then lived. Of an employee who was unsatisfactory he wrote: "Besides his want of health, he has a wife quite unfit for iron works, as she appears to be a fine lady, and expects to live with a delicacy not common in these parts, especially at iron works. The mistress of such a family ought not to wear silks, nor spend much of her time decking her person, or dressing her head, but rather by care endeavor all she can to promote economy and frugality. We shall, therefore, with reluctance, be obliged to part with Mr. Hicks when his year is up."

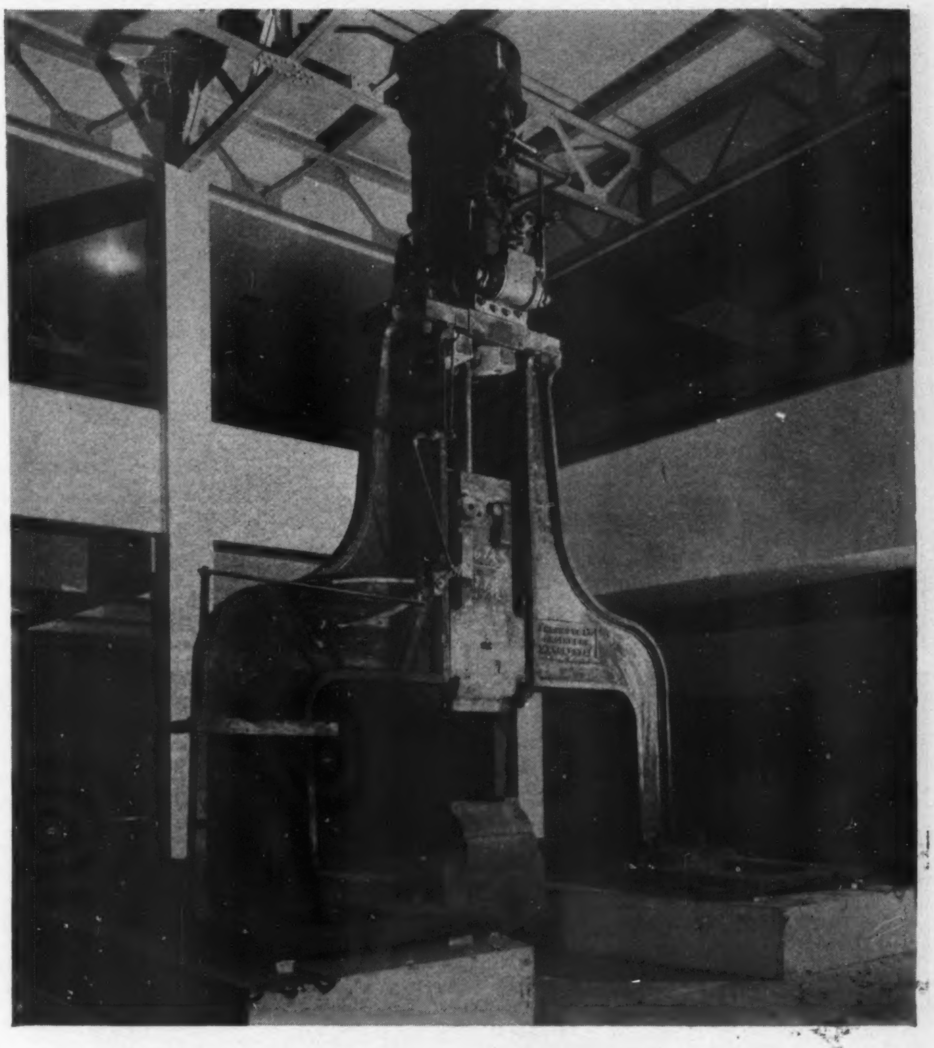
In an advertisement for someone to manage the forge at Union, he offered 60 pounds sterling a year for a sober, skillful man, with an increase of 10 to 15 pounds "if he behaves well and is found deserving of encouragement."

Among the employees at Union was Robert Taylor, who had come from Ireland in 1738 when 18 years old. He taught school for a time, then became a bookkeeper at Union Furnace. There is a legend that the excellence with which he penned a petition on behalf of the employees against some alleged wrongs attracted the attention of the management to him. In any event, he succeeded Archibald Stewart as works manager when the latter was transferred to Andover in 1769. He was the first of a direct line of five Taylors to manage the operations that have since become the Taylor-Wharton Iron & Steel Company.

Allen and Turner were Tories, but they kept their sympathies in check during the Revolutionary War and escaped difficulties. In fact, Allen sent a shipment of cannon balls to Philadelphia in 1775, directing that half of them be accepted as a contribution from him, although Turner was to be paid for the remainder. In the consignment were 175 balls: 16 of 32 pounds, 119 of 18 pounds, 29 of 9 pounds, and 11 of 6 pounds.

Taylor was also suspected of being pro-British, but when he was called upon to take an oath of allegiance to the colonial government in July, 1777, he produced a certificate showing that he had already proclaimed his loyalty. During the war, John Penn, the last British-appointed governor of Pennsylvania, and Chief Justice Benjamin Chew were held under parole in Taylor's home near Union Forge. It was intended to send them to Fredericksburg, Va., but through the intervention of Allen, who was Penn's brother-in-law, they were permitted to take asylum at Union. They lived there with Taylor in a stone mansion to which Penn gave the name of Solitude. The house, now covered with stucco, still stands in good repair and fully furnished. It was fitted out a few years ago by Taylor-Wharton as a residence for unmarried young employees, but it is at present unoccupied.

Taylor came to have full charge of all Hunterdon County holdings of Allen and Turner, including the mine, forge, furnace, and slitting mill. Allen died in 1780 and Turner in 1783, and they bequeathed the Union Tract to their descendants. Allen left his share to two grandsons, William 3d and John Allen, while Turner's equity passed to two nieces, one the wife of Benjamin Chew and the other the wife of Frederick Smith. In 1800, upon the application of William Allen 3d, the supreme court of New Jersey named a commission to partition the property among the four claimants. The commission surveyed the boundary lines of the various farms into which the tract was divided and marked out on a map 52 plots ranging in size from 50 to 300 acres each and appraised at from

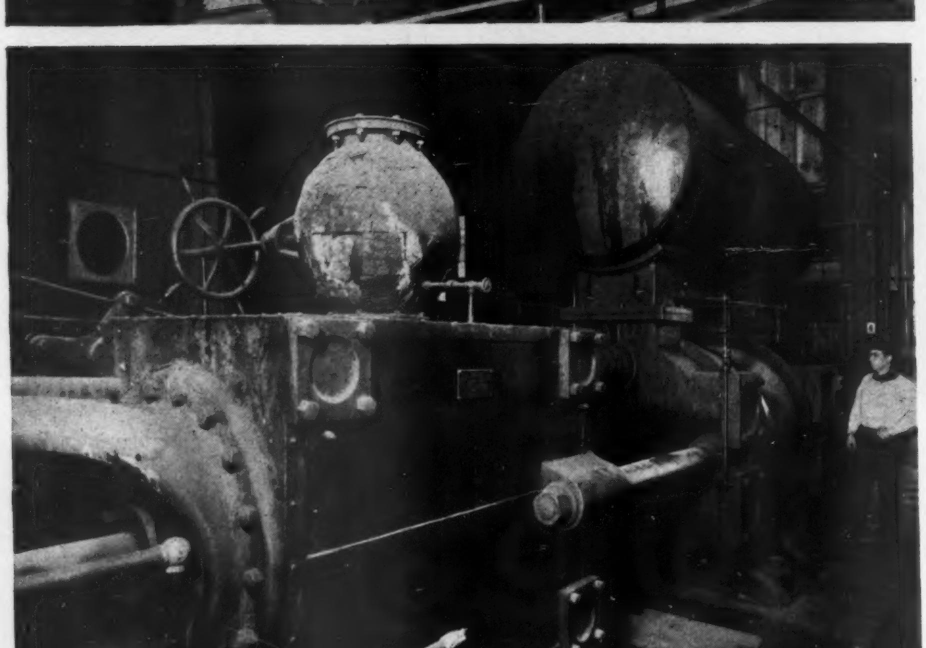


NASMYTH HAMMER

The invention of a steam-operated drop hammer by James Nasmyth, of Manchester, England, in 1839 was a great boon to the iron and steel industry, as it provided forging equipment much superior to that previously available. The hammer shown here was imported from England about 1850 and was used for many years by Taylor-Wharton at High Bridge. It is now in the Museum of Science and Industry at Chicago, Ill., where this photograph was taken. At the present time Taylor-Wharton makes no forgings.

$3 to $12 an acre. These plots were consecutively numbered and were arranged in four blocks of equal value, the block into which each plot fell being designated by colors. The commission then advertised that it would meet on March 17, 1802, at the house of Clement Bonnel, an innholder in what is now Clinton, N. J., to make the division. At that time, four slips of paper numbered from 1 to 4 were placed in a box, and four other slips, each bearing the name of one of the four owners, were placed in another box. A blindfolded man, Daniel Anderson, then drew a slip from each box, and continued until each of the four persons had been allotted his portion of the holdings. The record of this lottery, which was referred to as balloting, may still be found in the New Jersey archives at Trenton, and the validity of the title to every parcel of land that was once within the Union Tract today depends in part upon this drawing of lots.

Most of the property thus allotted was placed on the market, and many persons who had occupied portions of the land as tenants became owners by purchase. On March 12, 1803, William Allen 3d gave power of attorney to Robert Taylor to sell his portion. On the same date, Taylor bought for $1,464 Lot No. 14 which contained 366 acres. It included the house at Solitude, the forge, the mines, and much of the ground that is now within the limits of High Bridge. From that time on, the land and the iron workings remained in the Taylor family and the operations were conducted by Taylors, being handed down from father to son through five generations. It is extremely unlikely that a parallel sequence can be found in the annals of American manufacturing. Robert Taylor was succeeded by A. S. Taylor and he, in turn, by L. H. Taylor, who died in High Bridge in 1907 at the age of 97. The business was incorporated on August 7, 1891, as the Taylor Iron & Steel Company and L. H. Taylor was the first president He was



OLD BLOWING ENGINE

Until electric furnaces were installed a few years ago, all melting was done in Bessemer converters, and the air for blowing them was supplied by the huge machine shown here. This unit was built by E. P. Allis & Company, of Milwaukee, Wis., predecessor of Allis-Chalmers Company, and was set up in 1892, the year in which Taylor-Wharton made the first commercial alloy steel produced in the United States. A brass plate on one side of it bears the name of E. Reynolds, the manufacturer's superintendent, who contributed much to the design of the machine. It consists of a Corliss steam engine with a single 32-inch-diameter cylinder directly connected to an air cylinder of 48-inch diameter. The stroke is 48 inches. The flywheel is 24 feet in diameter, and the entire engine is more than 50 feet long. It weighs 35,000 pounds. It operated at 50 rpm. and delivered 4,000 cubic feet of air per minute, at a maximum pressure of 25 pounds. The machine is retained for possible use in case large orders, such as were received during the World War, should necessitate putting the converters back into service for a time. Blowing engines have been almost entirely superseded by turbo-blowers, which occupy only a small proportion of the space. In the lower picture, the steam cylinder is at the left and the air cylinder at the right.

followed by William J. Taylor. The last of the Taylors to head the management was Knox Taylor. Following his graduation from Princeton University in 1895, he spent seven years in mining-engineering work in the West. Upon his return to High Bridge, in 1902, he started to learn the business of his forefathers and worked successively in every department of the plant until he was familiar with all the operations. He became president of the company in 1905 and retained that office until his death on April 4, 1922. His cousin, Percival Chrystie, who had been identified with the company for many years, was elected to succeed him. Following Mr. Chrystie's election as chairman of the board of directors in 1929, George R. Hanks was named president and has since served in that capacity. He entered the employ of the concern in 1915, immediately following his graduation from Princeton University.

Not much is known regarding the details or extent of the operations during the period from 1780 until the coming of a railroad to the section about 1851. It seems fairly certain, however, that the works steadily turned out iron, chiefly for local needs. From time to time, some of it was marketed in Philadelphia, which entailed hauling it, by oxen or horses, a distance of some 70 miles. Neither is it known how long the local ore deposits were used. Judged by present standards, the ore was poor. It contained about 50 per cent metallic iron, was high in sulphur and titanic acid, and must have been difficult to cope with, particularly with the crude equipment that was available.

Increased activity that amounted almost to new life came to the Union works when the Central Railroad of New Jersey built through the section a line that extends from Jersey City to the anthracite coal fields around Scranton and Wilkes-Barre, Pa. The railroad provided economical transportation for coal and for a better grade of iron ore and improved the facilities for distributing the products. Equally important, it created a market for iron for railroad usage. As a result of this, the works at High Bridge, a name that a lofty railroad trestle gave to the community, turned its attention to making car wheels, and these were furnished to the Central Railroad of New Jersey for many years.

For a long time, these wheels were made of chilled cast iron: later, a patented combination steel-and-iron wheel was developed. Rolled-steel rims were purchased and cast-iron centers were poured in them, the two metals being fused together. Forged car axles were also made. During this period, the concern was known as the Taylor Iron Works.

A sweeping and far-reaching transformation in the character of the company's products was brought about as a result of the development of manganese steel by Robert Hadfield in England in 1887. The Taylor-Wharton Iron & Steel Company is today essentially a producer of manganese-steel castings, and it sends its products to the far corners of the earth. It originally embraced manganese steel for a purpose that proved disappointing; but having allied itself with the new metal, it searched for and found other fields for which it was adapted. Ever since then, the company's progress has been marked by repeated ferreting out of applications in which manganese steel excels other metals.

The turning to manganese steel is traceable directly to the fact that, in 1888, Dr. Henry M. Howe, distinguished metallur-

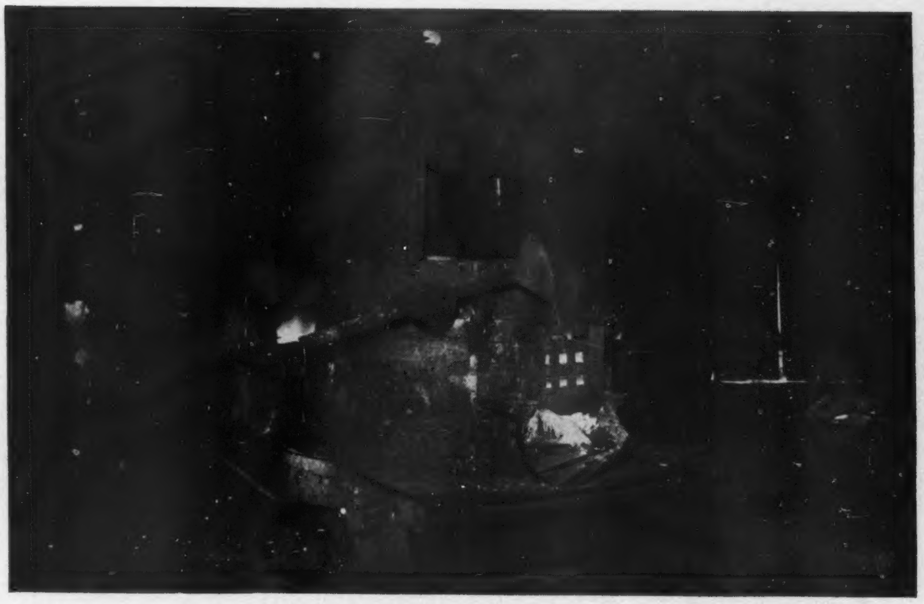
gist and a professor at Columbia University, wrote a book on steel in which he paid considerable attention to the new Hadfield alloy. When he submitted the manuscript to Mr. Hadfield, the latter was so impressed that he invited Doctor Howe to visit him. This he did in 1890, and out of their meeting came an agreement that Doctor Howe was to represent Mr. Hadfield in the United States and seek to introduce his processes and products in this country.

Upon his return to America, Doctor Howe found William J. Taylor, then manager of the Taylor Iron Works, receptive to new ideas. It seemed to him that manganese steel possessed superior qualities for making car wheels. Hadfield had already proved that it had great resistance to shock and abrasion and that, in a piece the size of a railway-car wheel, it was practically unbreakable. Its adoption was approved by the board of directors, and as the first step in the projected exploitation the Taylor Iron & Steel Company was incorporated.

A license was obtained from Mr. Hadfield, and the manufacture of manganese-steel car wheels was started. The first casting was poured at High Bridge on October 17, 1892. So far as is known, this marked the beginning of the alloy-steel-casting industry in the United States. High hopes were held for the new wheels, but it soon developed that this optimism was poorly founded. The wheels proved a failure in railroad service. They did not break; but, under the great weight imposed on it, the metal flowed, causing the wheel to bulge out at the edge of the wearing surface on the side opposite the flange. Ultimately, many wheels were sold for use on mine cars, where loads were lighter; but at the time referred to here the goose that had been relied upon to lay golden eggs was decidedly dead.

A new start had to be made in finding suitable uses for manganese steel. This was not easy, for the wheel episode had given the metal a bad reputation. Moreover, the new steel had proved itself very difficult to cast successfully. Fortunately, the company had the financial resources to persist in its efforts; and it was not long until a market was developed for mine-car wheels and also for the jaws of rock crushers.

Then came the startling discovery that manganese steel, while unfitted for railroad-car wheels, was superior to any other known metal for the tracks on which trains ran. This was the period when electric cars were replacing horse cars in street-railway service. The new cars were much heavier than the old ones, but had to utilize the same narrow wheels because various municipal and state laws prevented any change in the tracks. As a result, the heavier loads proved very destructive to the frogs and crossings of the light rails. A search for a more durable material was started. One of the manufacturers of such track work was the William Wharton Jr. & Company of Philadelphia which, in its efforts to solve the problem, consulted the Taylor Iron & Steel



ELECTRIC FURNACE

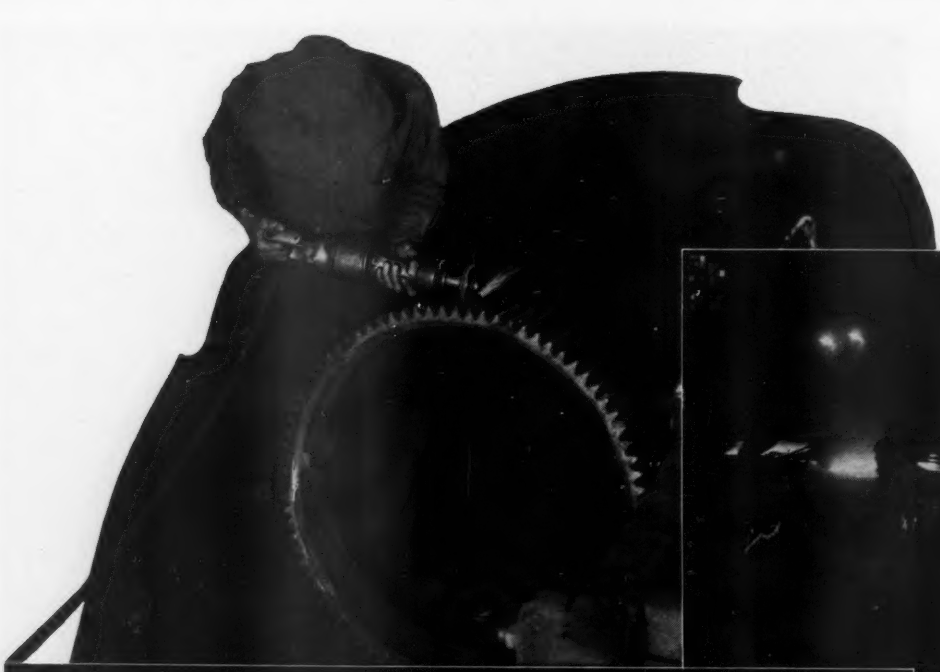
Pig iron, scrap steel, manganese-steel scrap, and ferromanganese are the raw materials that enter into Hadfield manganese steel, which ordinarily contains about 12½ per cent manganese. The ferromanganese is added after the other materials are in a molten state. Melting was formerly done in cupolas, and the steel was made in Bessemer converters, but this had the disadvantage of blowing out of the scrap much of the contained manganese. Accordingly, electric melting was adopted a number of years ago. The Heroult arc-type furnace shown here will melt 9,000 pounds at a time, and there is also a smaller Pittsburgh Electromelt unit. In addition, a side-blow converter is utilized when extra-large castings have to be poured. The ferromanganese has a manganese content of 78-82 per cent. The scrap from this foundry is high in manganese; and some of it is purchased by steel companies in place of spiegeleisen for adding manganese to their products.

Company. Experiments with manganese steel demonstrated its effectiveness, and on August 24, 1894, the first frog with a cast manganese-steel plate in its center was installed at Fulton Street and Boerum Place in Brooklyn. The traffic over this frog averaged one car every 27 seconds throughout the 24 hours, affording a quick test of the new material. Two months later, manganese-steel rails replaced chilled cast-iron rails on a sharp terminal loop at the foot of a 10 per cent grade on Market Street in Philadelphia. These and other installations proved successful beyond all expectations, and the Wharton Company acquired exclusive rights in the United States to use Taylor-Hadfield manganese steel for track work.

Despite the demonstrated suitability of the alloy on electric railways, the steam railroads were slow to accept it. For one thing they were skeptical of castings, being strong advocates of rolled rails. Not until the engineers of the Pennsylvania Railroad had witnessed a series of severe drop tests on manganese-steel castings would they permit them to be used in an intersection at grade where the line of the Union Traction Company crossed the Pennsylvania tracks in Philadelphia. The installation of this crossing, on January 22, 1900, marked the first use of manganese steel in a steam-railroad track subjected to locomotive traffic. Two months later the Pennsylvania Railroad placed a manganese-steel frog in the Broad Street Terminal in Philadelphia. This was soon moved to a location where frogs of ordinary Bessemer Steel averaged three months in service. After it had been in use 51 months, its surface was reground and it gave an additional 24 months of service, or a total of 25 times the life of the frogs previously used, before being replaced in September, 1906. Subsequently, cast manganese-steel rails used on a sharp curve of a subway railroad line in Boston outlasted the previously used Bessemer-steel rails by a ratio of 54 to 1. These and other convincing demonstrations firmly established manganese steel in track service, and it remains a favored material for that purpose today.

Soon after manganese steel was introduced, the company pioneered in its use for the manufacture of safes and vaults. It originated the principle of two-piece construction—body and door—instead of many plates fastened together. It is no longer active in this field, but safes and vaults formed of metal produced at High Bridge are to be found in many financial institutions throughout the country.

The William Wharton Jr. & Company obtained all its manganese steel from High Bridge, and this community of interests led to its absorption, in 1912, by the Taylor interests, and the Taylor-Wharton Iron & Steel Company was formed. In 1915 the manufacturing operations of the Wharton factories at Philadelphia and Jenkintown, Pa., were transferred to a new, modern plant that had been built at Easton, Pa.,



GRINDING

Manganese steel has the characteristic known as "work hardening," meaning that its hardness is increased when it is subjected to impact or pressure. This quality gives it its particular field of usefulness but also makes it a very recalcitrant material to process. Castings cannot be chipped, and all finishing operations in the foundry are consequently done by grinding. In the High Bridge plant are many types of grinding apparatus, and the combined effect of the sparks emanating from them resembles a pyrotechnic display. The view at the upper right shows a line of swing grinders in action, while the two other pictures illustrate uses of Ingersoll-Rand hand-held pneumatic grinders. The cleaning and grinding department at High Bridge is known as the fettling shop. This is British terminology brought over in 1892 by representatives of Sir Robert Hadfield who came to give instructions in the making of the new manganese steel. Somehow the name stuck, although it is probably not used in another foundry in the country.

about 25 miles from High Bridge. Since then, all track work has been finished there.

During this period of track-work development, additional new applications were being found for manganese steel. The high resistance of the metal to shock and abrasion suggested its suitability for certain parts of machinery used in hard digging and dredging, crushing, grinding, and conveying. Here again, its introduction was not easy, for the trade had to be educated to the peculiar qualities of manganese steel and to be convinced that its performance justified its comparatively high first cost. These efforts were successful, however, and paved the way for one of the principal applications of Taylor-Wharton products ever since. The Panama Canal was largely dug with power shovels provided with "Panama" teeth produced at High Bridge. These and many other parts for all types of excavating machines are supplied in large quantities today. An important part of the output also goes into dredges of both the ladder and suction types. The company has a patented lip for dredge buckets that renders this wearing part easily and quickly replaceable without the use of rivets, and this advantage contributes much to the world-wide business Taylor-Wharton does with the dredging industry.

In the meantime, research has continually extended the application of Taylor-Wharton manganese steel to various services where its particular virtues are an advantage. Metal mines and mills, coal breakers, quarries and stone-crushing plants, paper-pulp-working machines such as beaters and Jordans use it in large quantities, and it also finds employment in scores of other industries and processes.

The company has materially widened the scope of usefulness of manganese steel by developing a welding rod that makes possible effective repairs in the field. Hadfield manganese steel, containing 11-14 per cent manganese, is brittle when cast, but becomes very tough when heated to about 1,950°F. and quenched in water. This has the effect of putting contained carbides in solution. The metal must cool very fast to produce maximum toughness, and it is practically impossible to accomplish this in sections thicker than 4½ or 5 inches. To overcome this, research was directed towards finding an air-toughening manganese steel that would permit the pouring of heavier sections. The desired steel was obtained by adding a suitable amount of nickel, at the same time controlling the carbon and manganese content. Strangely enough, when a way had been found to pour thicker

RUNNING UP NUTS

The heaviest wear on a dredge bucket is on the digging lip, and buckets are therefore made so that this part can be replaced when necessary. Lips were formerly riveted on; but Taylor-Wharton has devised a lip whose ends fit into pockets on the inside of the bucket and which is locked in place by two bolts at the back. Such a lip can be renewed in a few minutes, as compared with several hours in the case of the riveted type. This picture shows a nut being run up on one of the 1½-inch retaining bolts by an Ingersoll-Rand impact wrench. The lip is meanwhile being hammered down tight. Previously, this operation required the services of two men with a long-handled wrench, and nuts could not be made as tight as with the tool illustrated.

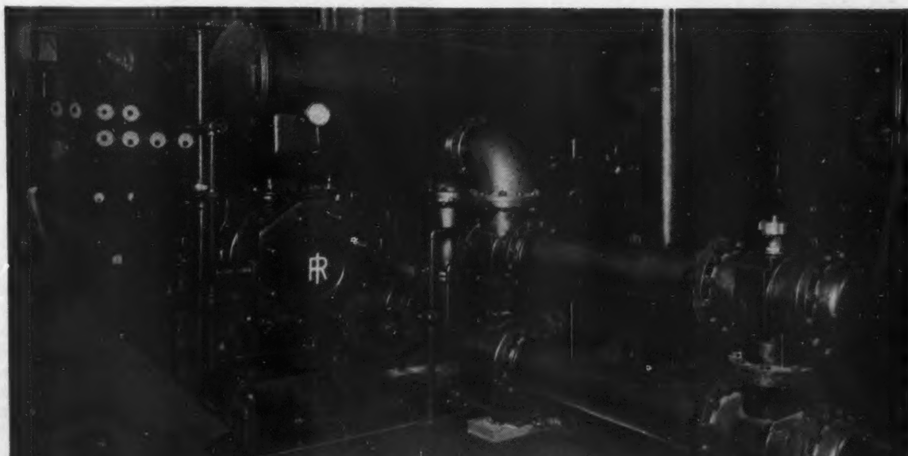
castings of the desired service qualities, few uses for them could be discovered. The new material seemed to be a white elephant until the happy thought occurred of testing it for welding qualities. Previously it had been almost impossible to make satisfactory welds of manganese steel because the heating of the material bordering the weld destroyed its toughness and rendered it brittle. Welds made with the new metal by the electric-arc process proved successful, and paved the way for prolonging the service life of impaired manganese-steel parts. This has had the result of offsetting in part the high first cost of manganese steel and has stimulated its use.

Although manganese steel comprises the bulk of the business, the company also makes some other metal products. The two chief ones are both specialties. Alnico permanent magnets are manufactured under license from General Electric Company. Alnico is a patented alloy of aluminum, nickel, and cobalt that has superior magnetic properties and that finds widespread use in radio-set loud-speakers and elsewhere. The metal must be cast, whereas ordinary magnet materials can be rolled. The casting technique that has been developed through the years at High Bridge stands the company in good stead in handling this metal. It is produced in a department entirely separated from the other foundry operations to avoid any possibility of contaminating it by contact with tools or furnaces used in the production of steel. Another specialty product is seamless-steel cylinders for various compressed and liquefied gases such as hydrogen, oxygen, nitrogen, helium and air. These are made in the Easton plant from billets, the process consisting of piercing the heated metal to form cups and then pushing these through a series of draw rings of decreasing size with a hydraulic mandrel. After the walls have been reduced to the desired section, the open end is necked down and the vessel is heat treated to relieve strains and to impart the desired strength and toughness. The cylinders are made to withstand internal pressures of as much as 3,800 pounds per square inch.

The age of the Taylor-Wharton Iron & Steel Company and the nature of its business have given it a distinction shared by few if any other firms in the United States. It has produced materials or munitions for every war in which the country has been engaged, including the early colonial conflicts with the Indians prior to the Revolutionary War. During the World War the company turned out shell-body forgings, 4-inch naval-gun rough-machined forgings, and steel castings for gun carriages. When the Armistice was signed, 538,136 shell forgings had been made with but 0.776 per cent rejections. This standard of performance was not equaled, it is said, by any other firm in the country.

Taylor-Wharton products are marketed through nine domestic branch sales offices, several foreign offices, and numerous agencies. The executive offices have always remained at High Bridge and occupy a building of which no one knows the exact age. It stands within five minutes' walk of the ruins of the crude iron works that Robert Taylor managed nearly two centuries ago.

Many of the historical facts in the foregoing article were obtained from a paper written by the Rev. Dr. Oscar M. Voorhees, of New Brunswick, N. J. During his pastorate of the Reformed Church of High Bridge from 1903 to 1909,, he started investigating the beginnings of the iron industry in the section and has since continued his research in an effort to fill in the gaps in the recorded history.

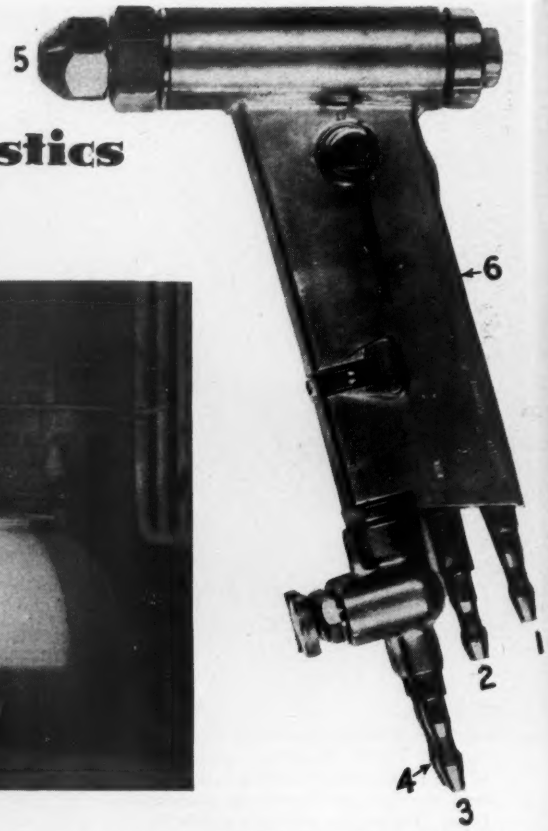


SOURCE OF AIR SUPPLY

Compressed air is employed in the foundry for operating sand rammers, air hoists, hand-held grinders, and other pneumatic tools used for cleaning castings, air jets for cleaning molds, and for various other services. The main source of supply is the Ingersoll-Rand Class PRE compressor illustrated here. It is driven by an Allis-Chalmers direct-connected 365-hp. synchronous motor and delivers 1,880 cubic feet of air per minute at 100 pounds pressure. Excess moisture is extracted from the air by the aftercooler shown at the right. On Sundays and holidays, when the demand for air is light, this machine is shut down and the load is carried by an Ingersoll-Rand 100-hp., belt-driven machine.

A Pistol that Sprays Powdered Metals and Plastics

R. G. Skennett



EVERY thoughtful manufacturer of machinery or tools strives to design his products with a minimum number of moving parts, thereby lessening upkeep charges and prolonging working life. The purchaser demands dependability, flexibility of application, and economy of operation. It was in answer to this set of conditions that the Schori spray pistol was devised. This pistol melts and sprays powdered metals, glass, and plastic materials that are fed to it pneumatically, and is used for forming protective coatings and decorative finishes for a multiplicity of services.

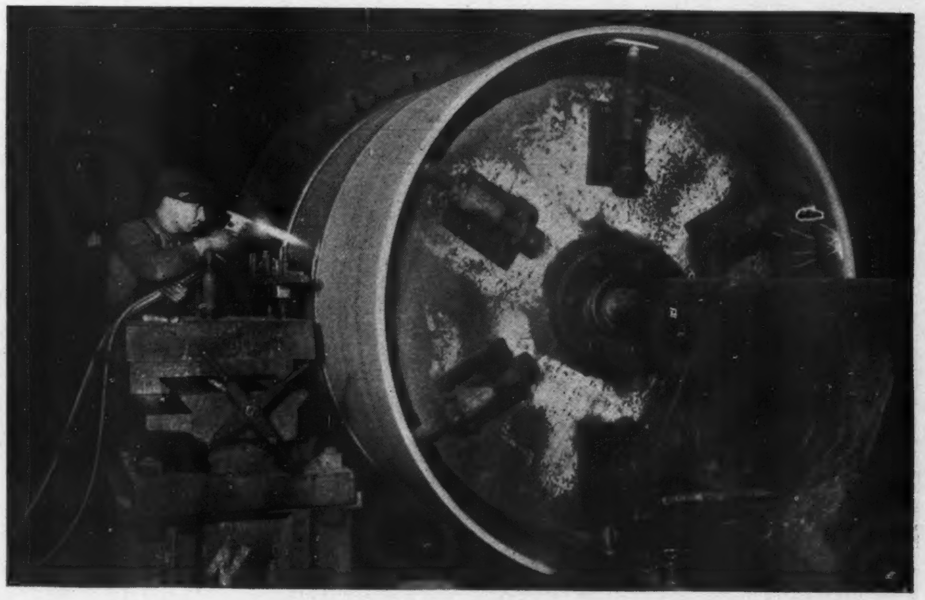
Spraying pistols that have metals fed to them in the form of wire are well known and widely used. In them, carefully built turbines or Pelton wheels actuate reducing gears that advance the wire continuously to the melting zone at the nozzle of the tool. As might be expected, that mechanism requires frequent lubrication, cleaning, and inspection to assure proper working. The pistol that utilizes metals or other materials in powdered form does not require moving parts that will wear out or need recurrent attention. Only the nozzle, where the actual melting and the spraying take place, is subject to wear; and an impaired nozzle may be removed and a new one screwed on in a few moments. These are the fundamental differences in get-up between the two kinds of pistols which, so far as the spraying of metals is concerned, do kindred work.

MINES TO DESTROY, BOATS TO SAVE

These pictures illustrate uses of the Schori spray pistol to condition articles designed for widely divergent purposes. At the upper left the steel shells of floating mines are being coated with a corrosion-resistant metal. The lower picture shows the lifeboats of a transatlantic liner. Their steel hulls have been sprayed with silica-zinc to protect them from the attack of salt-water spray and atmospheric moisture. Details of the Schori pistol are illustrated at the upper right. The key to the numbers: 1—Intake for powdered material being sprayed. 2—Compressed-air intake. 3—Oxygen intake. 4—Acetylene, butane, propane, or other gas intake. 5—Discharge nozzle. 6—Vent that can be closed by the operator's thumb to start the flow of powdered material to the flame zone at the nozzle of the tool.

The Schori pistol is operated by compressed air so brought into action that it draws the powdered material by an induced suction into the tool, then impels the suspended particles to the zone of the melting flame and imparts to the molten globules a high velocity that will carry them with an impacting force to the surface which is to be coated. The gases for the melting flame enter at the bottom of the pistol grip and are discharged through concentric annular outlets at the nozzle, where they create a fusing zone through which the powdered materials have to pass. The rate at which the powder is discharged from the pistol and the gases are fed to the flame are susceptible of very nice control.

The temperature range of the melting flame can be varied either by regulating the feed of the given gases or by the use of combinations of gases that have greater or lesser maximum temperatures when ignited. Because of this variable control, the Schori pistol can be adapted to meet the respective melting points of different metals or of any of the other materials that may be sprayed with it. Tin, for instance,



INDUSTRIAL USES

Metal spraying is extensively used by manufacturers of various metallic products to put on them protective coatings that will enable them better to resist corrosion and wear. Above is shown a large expansion joint being coated with bronze. The view at the left illustrates the application of silica-zinc to a complicated internal section of a submarine.

melts at 449°F., zinc at 780°, lead at 622°, aluminum at 1,220°, certain brasses at 1,780°, some bronzes at 1,795°, and copper at 1,981°, while chromium, iron, nickel, silicon, certain glasses, and tungsten have melting points that range all the way from 2,590° to 6,100°. While tungsten has been successfully sprayed with the Schori pistol, it is generally used to spray metals and materials within the lower melting range, even though it may be employed for those that have considerably higher melting points.

Whenever different metals or other substances are sprayed successively by the same pistol, both the air and gas pressures are adjusted for each one in turn to give the best operating conditions. To eliminate time-consuming complications, certain changeable parts, usually only the nozzle, are made ready in advance so that the operator can quickly make the required substitutions and continue his work with but a brief interruption. A given pistol can, therefore, be utilized to spray a number of materials, one after another, simply by making the replacements needed to fit it for the use of diversified fuel gases, such as acetylene, propane, butane, etc. In short, the predominant characteristic of the Schori pistol is its flexibility of service.

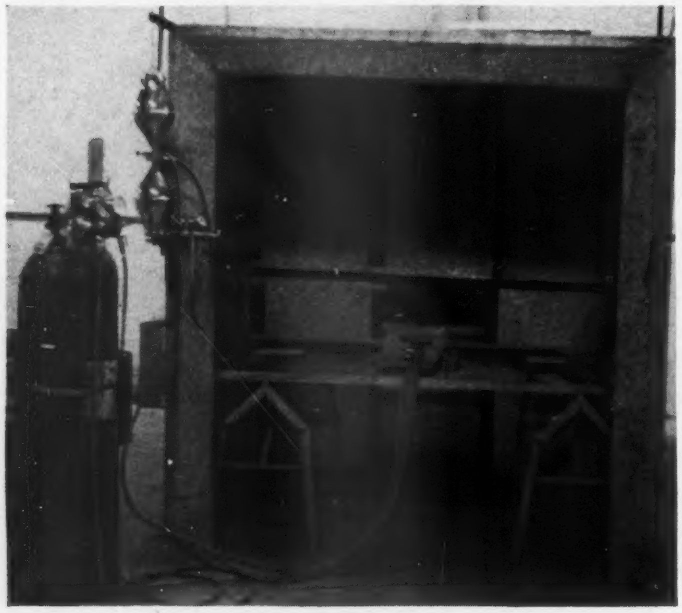
The flow of the powdered material from an exterior reservoir or container is induced by the transmission of compressed air through an interconnecting flexible tube and thence into an injection cone at the rear of the pistol. The action of the compressed air at the back of the pistol creates a vacuum within the powder-feed passage whenever the operator's thumb closes a hole that is in the handle of the tube and that otherwise is open to the atmosphere. The vacuum so produced causes the material to move from the powder container through the flexible tube to the injector cone, where the particles become entrained in the propelling air and are carried from that point onward to the nozzle of the pistol at high velocity. The instant the operator's thumb is lifted or shifted so as to uncover the hole in the handle, outside air rushes in through it, the feed vacuum is destroyed, the powder ceases to flow, and spraying stops instantly. Conversely, when the thumb closes the hole, spraying is resumed. When the material reaches the nozzle, compressed air drives it through the flame and on to the surface that is to be coated. The impacting powder forms a uniform and dense coat because each particle has been evenly heated in its extremely brief passage through the melting zone.

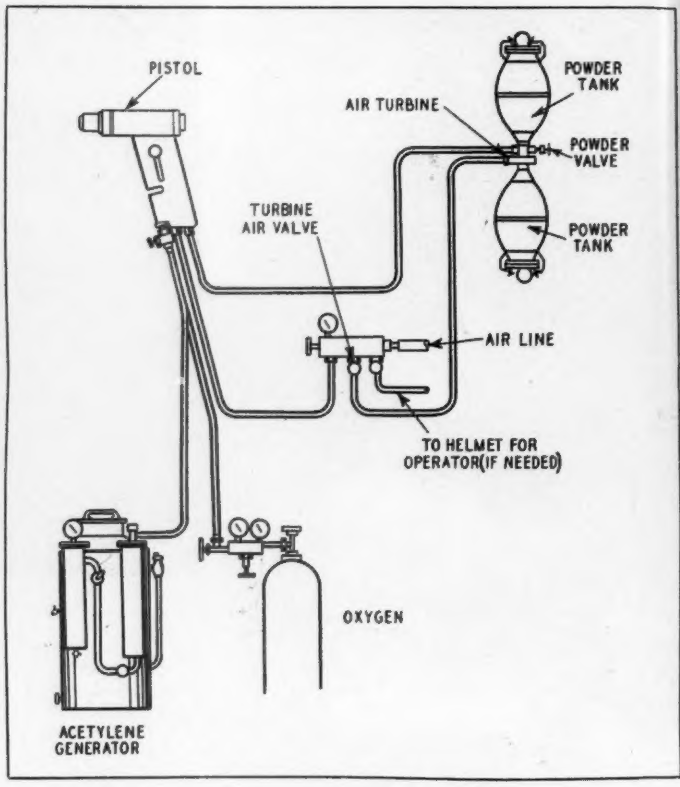
The powdered metal used may be either a direct product or a by-product of a manufacturing operation; and in either case, because of its source and form, it can commonly be marketed at a lower price than wire of a prescribed gauge and of like metal. This is readily understandable. Powdered metal of any desired grain size and specified purity is obtainable in ample quantities to meet the requirements of the new form of spraying pistol. Oxides of the given metal can be admixed with the powdered metal with satisfactory results because the heat of the melting flame is high enough to reduce the oxides and to combine them with the metallic particles so as to produce a solid and uniform film when sprayed. Obviously, if the oxides were not reduced and converted to a true metallic state then the film would be a spongy and imperfect one.

The flame used by the Schori pistols may be the result of combinations of oxygen, acetylene, butane, propane, or some enriched form of domestic gas. Combinations of oxygen and propane afford a flame of ample heat to deal with numerous kinds of brasses and bronzes, as well as with many modern plastics, when reduced to a powdered form. On the other hand, oxygen and acetylene give a flame of much greater heat and are therefore capable of fusing materials that have notably high melting points. Although tungsten has a melting point of 6,100°F., it has been successfully sprayed after passing through a pistol flame having a lower temperature than that melting point. The explanation is that the flame is hot enough to make the tungsten plastic, and when the metal is so softened it can be sprayed and deposited by an action that is seemingly akin to welding.

In the earlier forms of spraying pistols that were designed to handle powdered metals, difficulty was encountered in main-

METAL spraying has become important in recent years for protecting metal surfaces and also for building up worn metal parts to their original dimensions. This article describes a new piece of equipment that is designed primarily for spraying soft metals and plastics. It has been extensively used abroad and is now being introduced in America.





OPERATING ARRANGEMENT

The drawing shows the various working parts of the Schori system and indicates their relationships. Either half of the powder chamber may be swung into top position so that its contents will flow by gravity into the feed line to the pistol. A spraying booth ready for use is shown above.

taining a continuous flow of the material from an exterior reservoir to the pistol. The powder tended to pack recurrently in the flexible tubing of the feed line or otherwise to obstruct the desired movement. This occurred, it is reported, even though the powder was agitated by means of compressed air discharged into the reservoir. F. Schori has overcome this difficulty by devising a double-chambered reservoir that has the outward modeling of an hour-glass. At the junction of the necks of the two tanks he has interposed a small, enclosed, air-driven rotor that is mounted on ball bearings and set slightly out of balance. As this horizontal rotor revolves, its eccentricity causes it to transmit to the feeding container vibrations that effectually prevent any "bridging" of the material as it flows by gravity from the tank down into the tube that connects with the pistol. The rate of discharge from the container may be regulated by a valve located between the two chambers. The latter are arranged one above the other, and each can be swung in turn into the upper position and empty itself. The powder reservoir is, in reality, much simpler than the description of it.

One of the prerequisites to all successful metal spraying is that the surface to be coated first be thoroughly cleaned. Sandblasting is usually best for the purpose; and the protecting film should then be deposited with the least practicable delay before that surface is affected by the atmosphere or anything else that will interfere with the close adhesion of the sprayed film. It is equally desirable that the air used in the pistol shall be clean and dry. Therefore a properly equipped plant for the work should include apparatus for drying and cleaning; and these units are interposed between the compressor plant, the powder reservoirs, and the pistols. The operating air has an average pressure of 50 pounds per square inch at the receivers.

Virtually any shape and size of article can be sprayed by the Schori process before, during, or after fabrication. Rivets, screws, bolts, nuts, welds, etc., can thus be protected before they are assembled without any danger of damage during the subsequent work; and parts that have been sprayed can be bent or hammered without causing the coating to peel or crack. Metals can be applied so as to give decorative finishes of diversified kinds; and the film may be polished, if desired. Furthermore, areas covered with sprayed metals, for example, offer effective bases for ornamental or architectural painting. In the industrial arts, the process, potentially, has a wide field of use because it makes it possible to apply metals and plastics not only to metals but also to wood, plaster, and many other substances.

Several European governments, even a year or more ago, had standardized on the Schori process as a means of protecting some of the surfaces of submarines and other war craft. Ballast tanks, which are especially difficult to protect against corrosion on shipboard, are now metallized by this type of equipment; and the same method is employed to protect various valves, lifeboats, and other accessories of seagoing ships. Schori pistols are used to metal-spray ammunition, submarine mines, and the projectiles for large guns. In the latter case, the coating, aside from safeguarding against rust, acts as a lubricant and thus reduces the wear of the rifling which is so essential in that it imparts accuracy of flight to the projectiles themselves.

Within the past six months or so, the process has been proved to be practicable

Typical Applications of the Schori Spray Pistol

Equipment Sprayed	Metals Used
Tanks and drums	Silica-zinc, zinc, aluminum, tin, rubber, sundry plastics
Cylinders	Silica-zinc, aluminum or cadmium
Exhaust manifolds	Aluminum
Fire grates	Aluminum
Food containers and machinery	Tin
Electrical switchboxes, etc.	Silica-zinc, zinc
Motor-car mudguards and chassis	Silica-zinc, zinc
Insulators	Copper, tin, and zinc
Steel lifeboats	Silica-zinc, zinc
Deck fittings	Silica-zinc, zinc
Ventilating equipment	Silica-zinc, zinc
Street lamps	Silica-zinc
Window frames	Silica-zinc
Metal work generally (for protective purposes)	Silica-zinc
Wood	Silica-zinc, zinc, aluminum, tin, copper, bronze

SURFACING A LARGE STRUCTURE

The process is readily adaptable to outdoor use, although there it is of great importance that iron or steel surfaces be sprayed soon after being cleaned by sand-blasting or other suitable means, as any considerable delay may give atmospheric moisture an opportunity to form rust. This picture shows workmen applying a protective coating to the sluice gates of a tidal lock.

for the spraying of powdered glass on metal surfaces where the metal is of relatively thin section and susceptible of preheating to prevent the abrupt contraction of the glass film because of any chilling action of the metal. However, the ultimate industrial solution of the problem is still a matter of research. Success hinges upon the discovery of a glass having a low coefficient of expansion and also a comparatively low melting point. Borax glasses, which have the desired coefficient of expansion, unfortunately require high temperatures to melt them for spraying.

What is known as silica-zinc has been used for some time in a powdered form especially for coating metal surfaces exposed to the weather and to salt-spray and moist air from the sea. Silica-zinc is really a mixture of powdered zinc and powdered glass. The melting point of zinc is 780°F., and the fusing point of the glass is somewhat higher. Still, by employing a very finely ground glass in combination with the zinc, the Schori pistol, with a suitable mixture of gases, will melt both the zinc and the glass and produce a coating that is distinctly superior to one of zinc alone.

A variation in dealing with glass is to spray aluminum on to glass surfaces—the metal tending to increase the capacity of the glass to transmit or to reflect light, depending upon the application to which it is put. This metal has been used to coat circular disks of glass set in pavements for light transmission and as a substitute for silvering to make mirrors for special purposes. Mirrors of this sort for outdoor service do not have to have the full reflecting power of silvered glass, and are reported to have withstood the weathering action of three years of exposure. Metal spraying was recently employed to bond hollow blocks of glass constituting the wall of an exhibition building. The contact surfaces were covered first with an aluminum film, and this was followed with a top coating of copper. The blocks were then brought together in place and their edges soldered by the application of heat at moderate temperature. Furthermore, the pistol has lately been successfully used to spray coatings of such plastics as hard rubber, Thiokol, and Cardolac. Thiokol is a synthetic rubber, and films of it are described as resistant to oils, greases, and many acids and solvents that are destructive to unprotected metal equipment of various sorts.

To date, the Schori process has been utilized for coating containers and vessels ranging in size all the way from radio tubes to seagoing ships. The table that is on the preceding page will give the reader a good idea of some of its diversified applications.

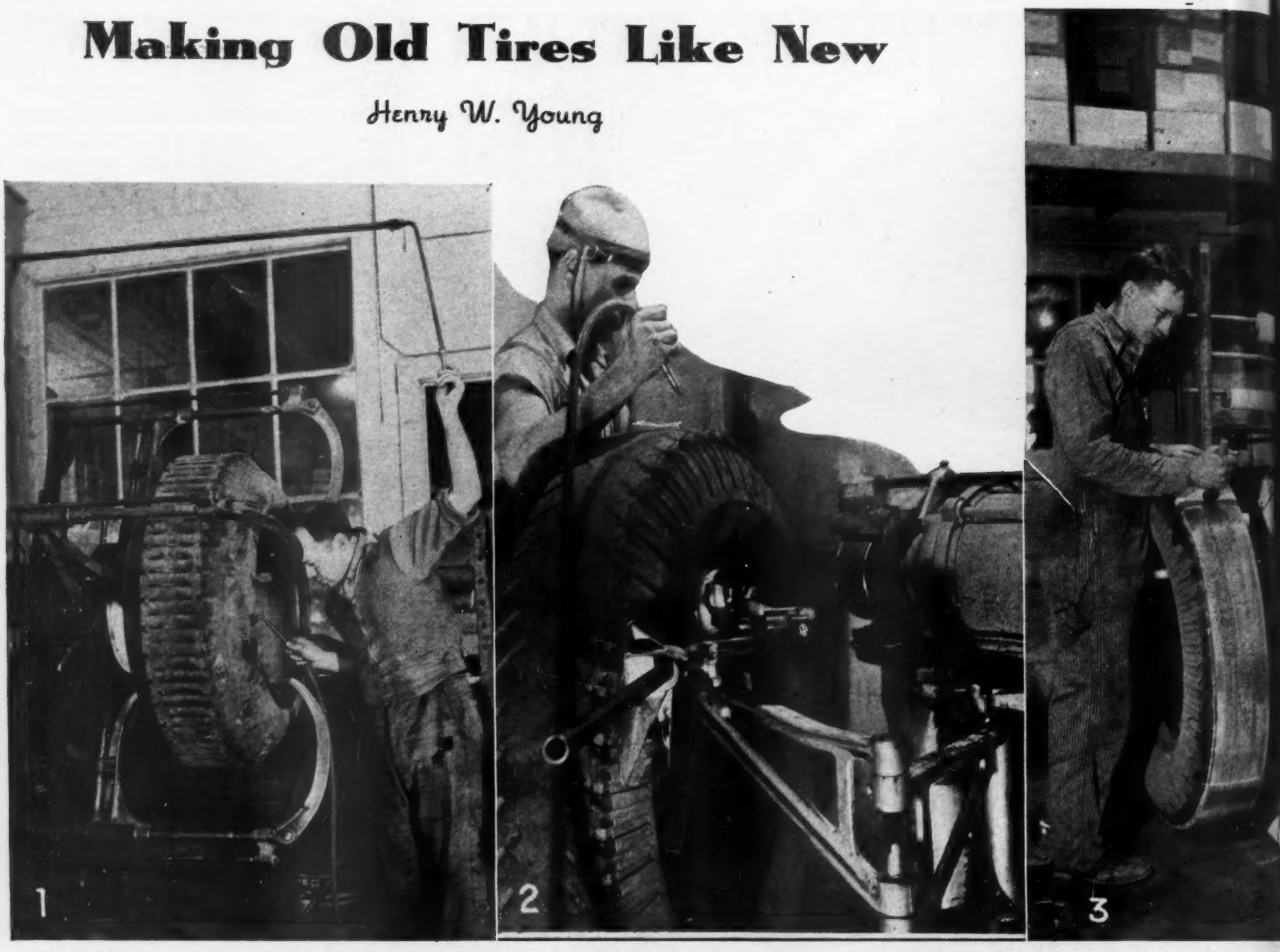
It is claimed that pistols of the Schori type are capable of laying a coating at the rate of 250 square feet an hour; and because of the durability of metal, as compared with paint, the resultant over-all economy gives the metal film distinctive advantages. Again, the new form of the spraying pistol illustrates how ingenuity and technical skill will, when the demand justifies, master many difficulties standing between laboratory performances and industrial applications. In America, the Schori Process Corporation is widening the fields of usefulness of this form of metal spraying that has already become well established among various European nations.

SPRAYING STRUCTURAL UNIT

This fabricated steel structure is being metal coated immediately prior to its installation. Note, at the left-hand edge, the 2-chambered reservoir from which the powdered metal is fed to the pistol.

Making Old Tires Like New

Henry W. Young



WHEN the machine age overtook the shoe-resoling business, it simply speeded up an old and honorable handicraft about twenty to one. When something very similar to shoe resoling was applied to automobile tires, there was no precedent for it. The new tire-retreading and recapping industry jumped bodily into machine production without having gone through the formality of displacing any type of hand "tire cobbler." And, properly, it is an industry now that is taking long strides every year. As yet it is a localized one represented by some thousands of relatively small plants, scattered throughout the larger cities, each with an equipment investment of from $1,000 to $20,000 and employing from two to twenty men on plant and outside service work. In the United States it is represented by the Tire Recapping Department of the National Association of Independent Tire Dealers; several trade publications of national circulation are devoted to it; and there are various other indications that it is here to stay.

It has been a matter of twenty years since we first began to hear of tire retreading, and less than ten since tire recapping came in. Many car owners, in the early years, felt that it would be a fine thing to have their tires "resoled" if it would work. But they were afraid of it. They had heard that new treads would come loose and travel down the road while the car would go into the ditch; that they would not wear well; that the treads were of the wrong design and would not prevent skidding. While there was probably some foundation for these criticisms when the process was in its infancy, the past decade has seen that phase of it pass because of the advance in methods and equipment.

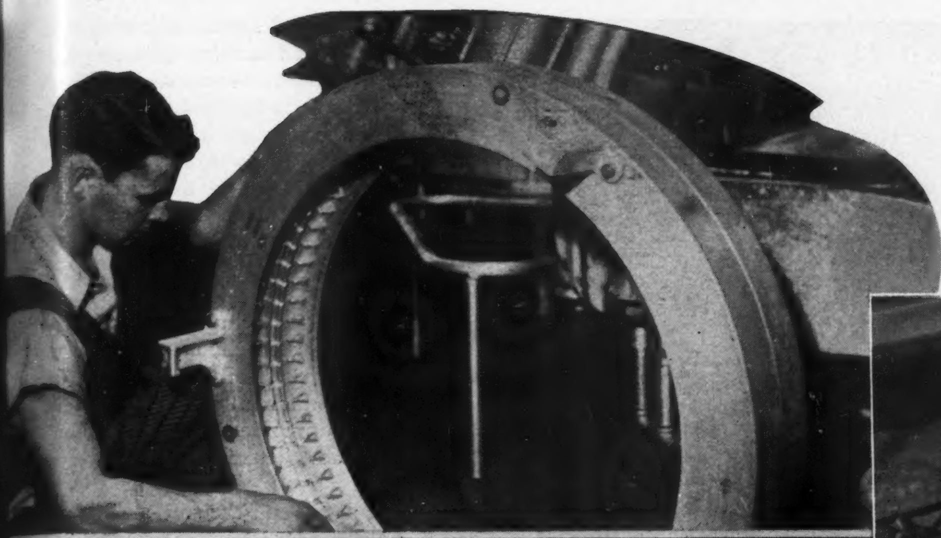
A few years ago, tires that were worn had to be replaced. But recapping and retreading now offer the motorist another course. As a consequence, a young and flourishing industry has been born.

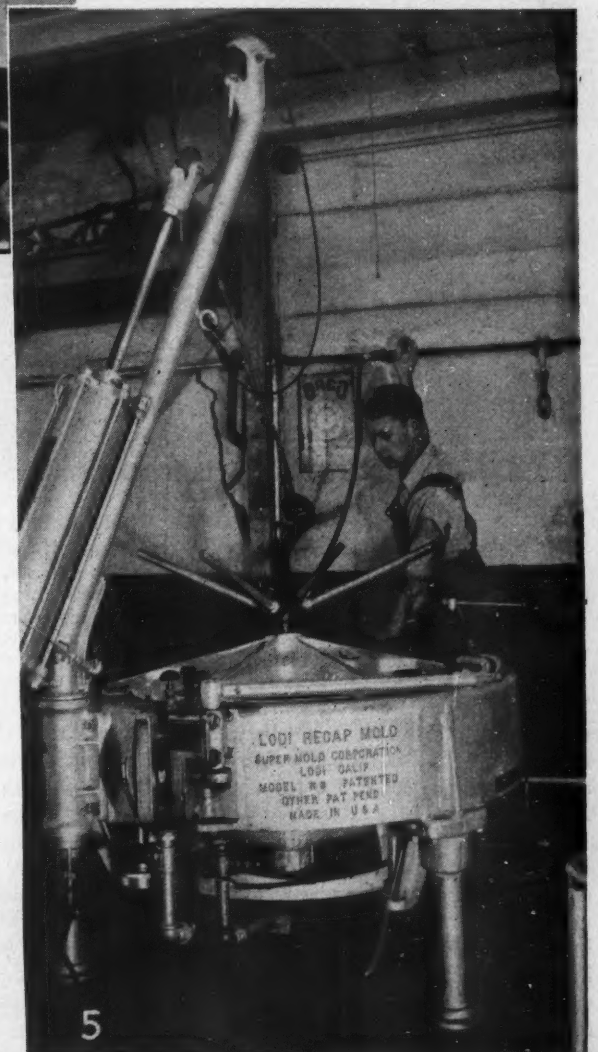
Tire retreading and recapping have reached the stage where they are an economic factor in the operation of automobiles and trucks. There are no "ifs" and "ands" about the fact that a casing with a sound carcass, properly rebuilt in one of these ways, is good for approximately the same mileage as it gave up to the time it was reconditioned. Also, the cost of such rebuilding throughout the country as a whole is just about half that of a new car tire and as low as one-quarter that of a truck tire.

This is no place to enter into a controversy as to the relative values of recapping and retreading. Both processes have their own merits and their own advocates. Prices are practically the same for both, and the operating results obtained are similar. However, as there has been some misconception as to the two methods, they will be briefly compared.

In retreading a tire casing, all the old tread is removed, together with the rubber well down the sides, almost to the fabric itself. The whole is then built up with new rubber and vulcanized. As there is a relatively large amount of new rubber to be cured, heat must be applied to both the inside and the outside of the casing.

In recapping, no rubber is removed from the tire. The tread is simply cleaned by buffing the entire face of the tire just enough to expose clear rubber to provide a good surface. It is then built up with new rubber to the original thickness of the tread. As there is not so much new rubber





SEQUENCE OF OPERATIONS

With the tire held open by air-operated hooks (No. 1), the operator cleans the interior with an air jet and then examines the surface for breaks or flaws. The tire passes inspection and then goes to a buffing machine, where a rasp-faced wheel (No. 2) takes off a thin film of rubber, leaving a clean surface. During this operation, an air jet blows away refuse. The buffed surface is next coated with cement, and a rubber strip, called a camel back, is laid on (No. 3). The tire, with the camel back in place and with the inner tube inside it, is mounted on a special rim and encased in a metal mold, or matrix (No. 4), which forms the tread. This assembly, which is too heavy for a man to lift, is picked up by an air hoist and placed in a recap mold. The mold (No. 5) is closed and air is introduced into the tube, forcing the camel back into the recesses of the matrix. Steam is then circulated through channels in the matrix to vulcanize the new tread. After the vulcanizing has been accurately timed, the mold is opened and the tire torn out of the matrix by the air hoist (No. 6). The owner (No. 7) looks over the reconditioned tire, which has as much rubber on it as it did when it was new.

MAKING SECTIONAL REPAIRS

Some tires have been damaged in spots but are otherwise all right. In such cases, the area affected is cut out (left). New fabric is anchored in place, new rubber is applied and then vulcanized in the machine shown on the right. Top and side plates mold the outer surfaces. The necessary heat is applied inside by introducing steam at 60 pounds pressure into a "steam bag." The additional pressure required for the molding is obtained by admitting compressed air.

to handle in this case, it can be cured by heating only the outer surface by a machine that differs somewhat from that used in retreading.

Whether the process is retreading or recapping, compressed air is a necessary adjunct to the highly specialized equipment. It does all the heavy lifting and pulling; exerts the high internal pressures used in connection with the vulcanizing and curing of the rubber; and performs such minor operations as blowing out, cleaning up, and inflating the finished tire.

In order to follow the procedure through the various steps, the modern plant of Ray Grimshaw, in Portland, Oreg., will be described. It is a recapping plant that has been in business for about five years and to which several pieces of new equipment have been added recently. It can handle all types and sizes of tires for automobiles and trucks, completely recapping them or sectionally repairing them, as may be called for. Here comes a big truck tire for recapping. Suppose we see what happens to it during its stay of 48 hours or more in the plant.

First, it is hoisted on to a tire spreader for minute inspection to determine if both carcass and rubber are in condition to warrant rebuilding. If they are not, the plant operator will be the first one to say so. The men in this business have been at it long enough to have built up a regular trade and much good will. To recap a worthless tire just to get a job is against their own best interests, for what they have to sell is a service—tire miles, and they must make that service pay the customer.

So on the spreader the tire goes. Through the agency of air-operated pistons, hooks on each side seize the inner edges of the casing and lay it wide open. The operator then reaches in with a compressed-air jet and thoroughly cleans the inside preparatory to inspecting the fabric surface inch by inch. If it passes inspection, the tire goes to a drier, this being the wet season, and there it reposes for 24 hours, heated by steam coils, until all moisture has been driven from the cord carcass. This is essential to insure perfect adhesion of the rubber. In the dry season, this step may be dispensed with.

The next machine in line is the buffer, also sometimes called the tack rasp. This is of the replaceable band type, driven by a 10-hp. motor. Supported on a swing frame, the tire is moved until its tread is in contact with the rapidly revolving buffer wheel. This removes the film of old rubber, exposing a fresh rubber surface. As the operator works, he blows off the rubber dust and shavings with a compressed-air jet. At the same time an exhaust system, driven by a 6-hp. motor, clears the small room of all dust and fumes. As a further safety precaution, the operator wears a screen mask.

The tire is now ready for the application of the "camel back." In an adjoining department, the buffed surface is given a coat of cement, and the camel back, or rubber recap strip, is laid on by hand and allowed to air dry for one hour. The strip ranges in thickness from 13/32 to 18/32 inch. The amount of rubber laid on in any case is enough to fill the mold and to enter all the openings of the matrix after pressure is applied.

There are six Lodi molds, two each of three sizes. With their three complete sets of matrixes, it is possible by means of these molds to recap any size of passenger-car or truck tire. The different sets of matrixes are necessary to provide the three specific patterns of tread. These are the conventional highway tread, the lug-type tread for mud and snow, and the stop-and-start tread. The customer takes his choice. Of course, all the multiplicity of patterns available in the tire market cannot be duplicated with them, but one can be selected that will be comparable in performance to that of any type of tire made.

The matrixes weigh several hundred pounds each, and a big truck tire itself is no mean lift for a man. Therefore, each mold is provided with an air hoist that easily juggles the matrixes and tires into position with no effort on the part of the operator except to push a lever. The lift has a capacity of about 500 pounds; and only a few minutes are necessary to change matrixes and to insert a tire.

When the tire is in place on a special rim and the mold is closed, air pressure is admitted to a tube in the casing. Expansion forces the rubber camel back or recap strip into every nook and orifice of the matrix to form the pattern of the tread. The equipment can be accurately adjusted to any tire of any class so that the rubber will exactly fill the matrix, thus eliminating unnecessary carcass strain. Pressures used are 125 pounds per square inch for passenger tires and up to 180 pounds for truck tires.

The rubber is cured by circulating steam at 60 pounds pressure in cavities in the mold. Steam is developed by a 15-hp. Kerrick gas-fired boiler that is fully automatic in operation and control. After curing, the tire, with a brand new tread as thick as the original, is ready for service.

In cases of blowouts and other kinds of injury to a slightly worn tire, it is not always necessary to recap completely. The tire may be repaired by cutting out the damaged part and using what is known as a Tru-Flex unit section to build up the fabric. This is made of a prestretched cord fabric that is obtainable in various plies, widths, and lengths, sufficient for tying in and affording a safe anchorage. New rubber is then applied and vulcanized. This work is done by sectional repair vulcanizers. In the Grimshaw plant there are three Lodi vulcanizers and one spot press. No matrixes are used in these machines, the tread being formed by replaceable and accurately adjustable top and side plates.

In sectional vulcanizing, compressed air performs still another function. As both sides and tread are involved, it is advisable to apply steam heat both inside and out. Heat is introduced into the casing by means of what is known as a steam bag. In addition to the heat, this bag, by expansion, also furnishes the pressure that forces the rubber against the top and side plates. The 60-pound steam pressure is not sufficient for this purpose, so it is supplemented by compressed air, thus raising the pressure in the bag to as high as 175 pounds per square inch for heavy work. Air for all the operations in the recapping plant, as well as for tire inflation in the service department, is supplied by an Ingersoll-Rand Type Thirty 5&3x3½-inch compressor. It is driven by a Westinghouse 15-hp. motor.

In view of the fact that the two largest Lodi cappers require high and nearly uniform pressures, it is necessary that the discharge pressure of the compressor be maintained within 4 pounds of constant. Therefore a special start-and-stop control switch is provided in addition to the regular starting switch. This special switch cuts out at 186 pounds and in at 182 pounds.

Some day you may find in your car a ticket reminding you that the tread on your tires is nearly gone and that such and such a company is prepared to recap or retread them. This type of advertising is called car spotting. Or you may receive a notice concerning it in the mail, read about it in newspaper ads, or hear about it over the radio. These are the usual methods by which the tire-rebuilding people promote business so far as the passenger-car owner is concerned.

In the maintenance of tires for fleets of trucks, which involves a large amount of work, the business is handled on a more specialized basis. What the tire-recapping organization does in this case is in effect to guarantee the owners that their tire cost over a period of time will be lower than by the wear-out-and-trade-in method. As a rule, accurate records are kept of tire cost and performance, and it is not difficult for the tire rebuilder to prove his contention if he can once get in, because there are the figures which can be compared with the results that he is able to show.

Ray Grimshaw maintains the tires of a large number of fleets, ranging in size from 6 to 80 cars each. A service man calls on each concern every day, checks the tires of every truck that is in the garage, and keeps complete records of all the tires in use. Whenever a tire shows the need of attention, suggestions are made as to the best method of treating it. If it requires sectional repairing, or is worn sufficiently to make recapping advisable, the service man brings it to the plant, where it is reconditioned. It is then returned, put back on the equipment, and its reëntry checked. This pick-up-and-delivery service is free.

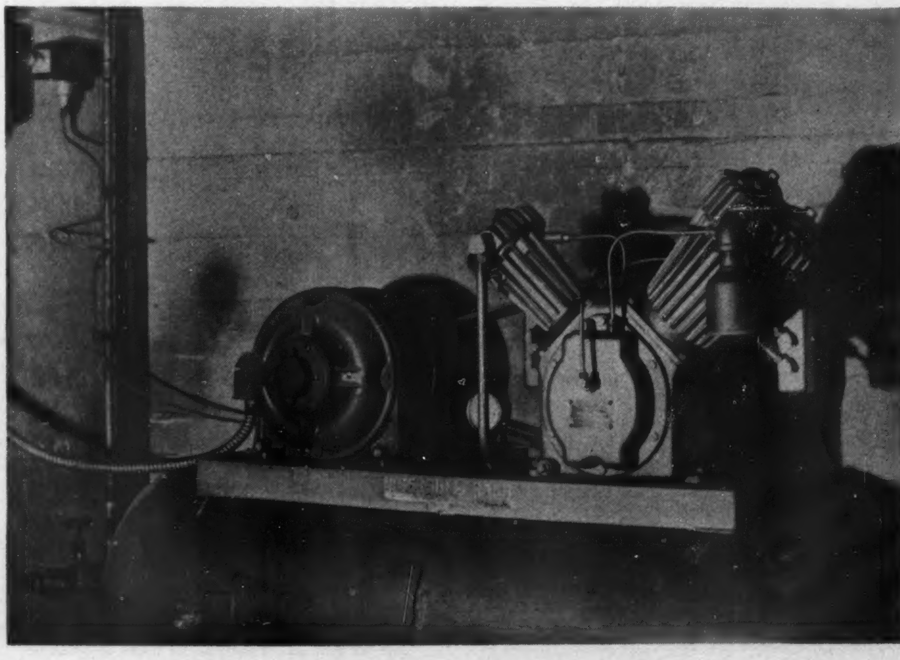
The tire-rebuilding company is really the tire-maintenance department of the fleet. On that basis, it is to the interest of the former to keep tire-mileage costs at a minimum, for if it is not able to show a saving, the customer will certainly not retain its services. Such work is ordinarily done on the strength of mutual satisfaction rather than by contract covering a specified period of time. For handling work of this description, the company has three outside service men with suitably equipped cars. A portable air compressor that can be quickly mounted on any of the service trucks is available for inflating tires on any fleet truck that experiences tire trouble away from the usual service station where air is available.

Another type of customer is the contractor who operates fleets in connection with highway building and large construction projects. The contractor, as a rule, sends his tires in for recapping and vulcanizing. Not only are truck and carryall tires taken care of but many road-grader tires also are now coming in. If the work is close by, the company service men may follow and keep a check on the fleet as carefully as they do in the case of the local customer. This is not practicable on distant jobs; but many contractors have their headquarters in the city, and these are the points of contact in developing the trade. As a result, tires reach the plant regularly by truck or train from places several hundred miles away.

How do new-tire dealers look upon this business? This is a question that naturally arises. It just so happens that the majority of tire-recapping and retreading plants are run by tire dealers. Sometimes they are supplementary, in a small way, to the dealer activities, and in other cases the tail is now wagging the dog. Ray Grimshaw, for instance, has the Seiberling tire agency for Portland. He finds that the tire-rebuilding business actually stimulates new-tire sales. While it is true that some tires, for trucks especially, may be recapped as many as four or five times, there is a limit to it, of course. After a car owner has received good service from his rebuilt tires and has confidence in the concern rendering that service, it is only natural that he should turn to it when the time comes to buy new tires.

To most passenger-car owners who do not trade cars every year, tires represent more or less of an economic problem. Those who have gone into the matter with thoroughness will tell you that when the tread on your tire has reached the stage where it is smooth, you have worn out only 30 per cent of your investment in tread, sides, and carcass generally. Three courses are then open to you. One is to keep on running until you are as close to the fabric as you dare go, and thus to pick up a few more per cent of the investment. However, this increases the hazard of operation; and, as the treads grow thinner, more and more punctures occur with attendant repair costs. Another way is to trade in for new tires and let the trade-in allowance pick up an additional percentage of the first cost.

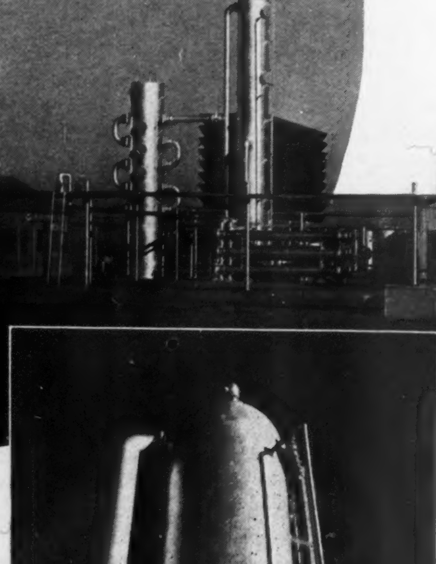
According to tire recappers, the best method of all is to rebuild the tire, and thus to provide one that is essentially as good as new at approximately half the cost of the original investment. On the face of it, and judging further by the rapidity with which these plants are springing up and the way in which they seem to be rushed with work at all seasons, it would appear that they must have the best of the argument.



SOURCE OF AIR SUPPLY

The compressed air is furnished by this Ingersoll-Rand Type 30 unit. It is a 2-stage, air-cooled machine that has a maximum discharge pressure of 200 pounds. It is driven by a 5-hp. motor.

A Natural-Gasoline Plant in New Mexico



PLANT VIEWS

At the top is a general view of the plant. The column at the left is an absorber, where the gasoline is absorbed from the gas by gas oil, resulting in what is termed fat oil. The latter is then distilled in the taller of the two towers in the center, and the product is purified in the fractionating column at the right. The bottom view shows the still at close range.

DURING the past few years, a major oil field has been brought into production in northwestern Texas and southeastern New Mexico largely as a result of the application of the science of geophysics. In reality, it is a series of fields that extends 175 miles in a north and south direction along the west side of what is known as the Central Basin uplift. Collectively, the fields make up the Permian Basin, a name derived from the fact that the oil-producing formation is of the Permian period. This group of fields stretches from the Yates pool in Pecos County, Texas, to the Hobbs field in Lea County, New Mexico. Just south of Hobbs field and at the northern end of the chain are the Monument and Eunice fields which, although separately named, are virtually continuous.

The Eunice field as at present defined covers some 20,000 productive acres, and an active drilling campaign is still in progress there. The wells average 3,200 feet in depth. Actual ownership of the land is greatly divided. Leases on it are held by various oil companies, including many of the principal ones, and the work of development and production is in their hands. Among these is the Skelly Oil Company, which is extracting gasoline from gas from its own wells and from gas that it buys. The natural-gasoline plant at Eunice handles 32,000,000 cubic feet of gas daily and makes 22,000 gallons of gasoline, or 2/3 gallon for every 1,000 cubic feet. The gas is obtained from 135 wells; but this number will be increased to around 200 when drilling in the area under consideration is completed.

Two pipe-line systems are required: one set of gathering lines to deliver the gas to the plant, and another set to return the residue gas to the leaseholders in accordance with the law. In some cases the leaseholders use the gas as fuel for driving engines in pumping wells or for operating equipment in drilling additional wells. Where they have no need of it, it is wasted to the atmosphere. In conformity with the usual procedure, a meter is placed at each well to record the quantity of gas taken from it. Once every three months the gas is tested to determine its gasoline content per 1,000 cubic feet. Payment for the gas is based on the monthly average of the daily selling price of gasoline, as published by *National Petroleum News*.

The bottom-hole pressure is from 600 to 700 pounds per square inch. To maintain a low gas-oil ratio, that is, to make each cubic foot of gas raise as much oil as possible, back pressure is held on the wells. The state requires that packers be installed near the well bottoms. These serve to direct the course of the gas so that it will tend to propel oil to the surface. At each well there is set up a separator through which the oil-and-gas mixture passes. There the oil is removed and fed into a pipeline gathering system by means of which it eventually reaches a refinery. The gas flows out of the top of the separator and thence into the pipe line that takes it to the gasoline extraction plant.

The plant is designed to operate at 30 pounds pressure. Accordingly, it is desirable to maintain a back pressure at the wells of around 35 pounds, as that will insure delivery of the gas to the plant at the prescribed pressure. Actually, however, the

back pressure varies at individual wells, and the range for the group is from 2 or 3 pounds up to 40 pounds. In some wells the desired pressure cannot be reached: in other cases the pressure is intentionally held down by the lease operators, for when this is done a proportionately higher quantity of oil is lifted by the gas.

As a consequence, half the gas, or 16,000,000 cubic feet a day, reaches the plant at the operating pressure. The remainder is at or below atmospheric pressure; and in order to raise it to the required 30 pounds, it is passed through gas-engine-driven compressors. There are eight of these duplex, horizontal units, each with compression cylinders of 18-inch bore and 20-inch stroke. A ninth and similar machine compresses gas in one cylinder and butane in the other. The latter is extracted from the gas during the plant process and is expanded to provide refrigeration for cooling the lubricating oil for the varied machinery in use there.

All the gas, at 30 pounds pressure, is directed into the bottom of one of two absorption towers. These are cylindrical vessels about 40 feet high and 6 feet in diameter. The ascending gas meets a descending stream of oil, known as gas oil, that is made to absorb the gasoline vapors. The mixture of absorption oil and gasoline, called fat oil, is run from the bottom of the absorber through a heat exchanger and then to a still into the base of which live steam is admitted. The gasoline is distilled, the vapors being withdrawn from the top and led to condensers, where they are liquefied. The condensate next passes to a fractionating tower where the gasoline is purified by removing excess propane. The gasoline can be taken off in the form of 16-, 18-, or 26-pound vapor-pressure grade, as desired.

Ordinarily the plant makes what is known as 26-70 grade gasoline, which means that its vapor pressure is 26 pounds per square inch and that 70 per cent of it will volatilize at 140°F. The vapor pressure is controlled by the amount of butane that is permitted to remain in the gasoline. In addition to the gasoline, approximately 2,000 gallons of butane is being produced daily. This is compressed and used as fuel for gas engines operating well-drilling equipment in sections where little or no natural gas is available.

The gasoline is not suitable for use as it comes from the fractionating tower. Both it and the butane are passed through a caustic wash to remove hydrogen sulphide, which is an undesirable corrosive compound. They are then treated with solid cuprous chloride to convert compounds known as mercaptans into forms that will not be objectionable. (A mercaptan is produced when sulphur replaces oxygen in an alcohol.) This conversion of the mercaptans is termed "sweetening" the gasoline, which must be rendered sufficiently free of sulphur to enable it to pass the so-called "doctor" test. The mercaptans are largely responsible for any bad odor in gasoline, and they are corrosive because of their sulphur content. They also have a deleterious effect on color and tend to promote the formation of gums. The natural gas from the Eunice field has a high mercaptan content—in fact, one of the highest known. Because of their distinctive odor (which is characteristic of all sulphate-process paper-pulp mills), mercaptans are frequently added in small proportions to bottled gas and natural gas distributed in cities to give warning of leaks. Some of those obtained in the Eunice plant are sold for that purpose. The gasoline is not marketed as motor fuel in the form in which it leaves the plant. Instead, it is sold to refiners who blend it with other gasoline to increase its volatility, octane rating, and other motor-fuel specifications.

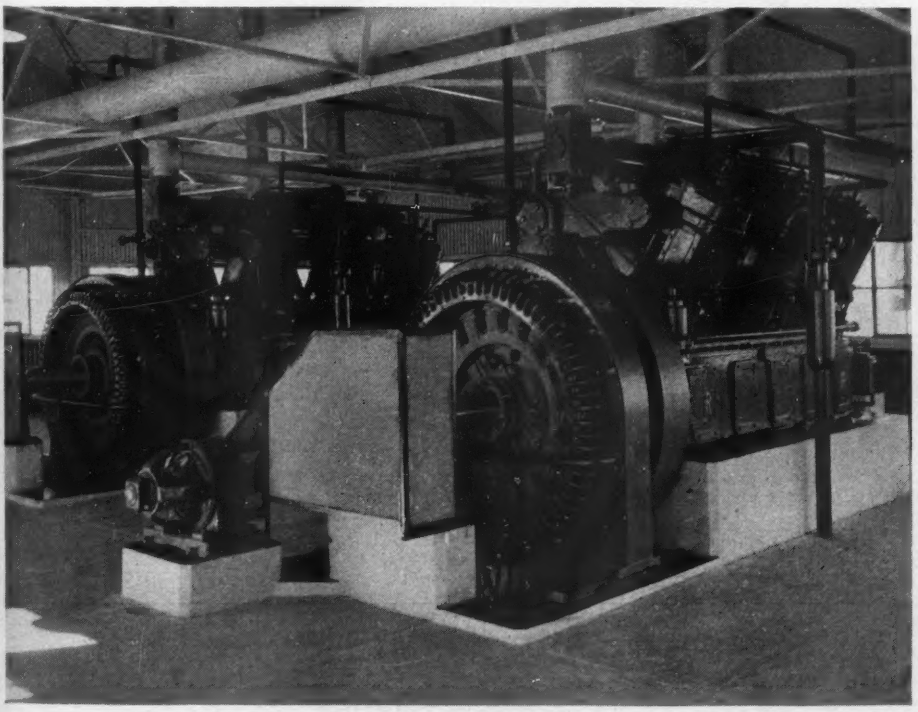
The electric power required in the plant is supplied by two gas-engine-driven generators. The gas engines are of the Ingersoll-Rand PVG Type, and each is a 6-cylinder, 4-cycle unit operating at 400 rpm. and rated at 275-hp. Each is direct connected to a General Electric 175-kw., 80-per-cent-power-factor, alternating-current generator that produces 440-volt, 3-phase, 60-cycle current. Belt driven from an extension on the generator shaft of each unit is a General Electric 7½-kw. direct-current exciter.

The PVG gas engine is identical with the power end of the XVG compressor that is widely used in oil fields and industry, and of which installations totaling more than 175,000 hp. have been made since its introduction seven years ago. The engine is built with a V-type cylinder arrangement that reduces torsional vibration and insures smooth and economical performance. This multiple-cylinder design also divides the load, making it possible to employ small cylinders with thin wall sections that promote cooling.

Electric power is used for driving oil- and water-circulating pumps and three air compressors, as well as for lighting the plant and the employees' houses. The generating equipment provided is more than sufficient for these requirements, and surplus energy is sold to the New Mexico Power Company which retails it to consumers in the Town of Eunice.

There are four air compressors in the plant, all of I-R manufacture. A steam-driven 8x8-inch, single-stage Class FR machine supplies air at 15 pounds pressure which is mixed with the fuel gas of the gas engines in order to reduce its Btu. content. A 12x10-inch, belt-driven Class ER unit furnishes air for the air-lift pumping of water. The latter is obtained from wells 160 feet deep; and after the needs of the plant are taken care of there is a large surplus that is sold.

Starting air for the gas-engine units is supplied at 250 pounds pressure by a 10-hp., air-cooled, 2-stage Type 30 machine. A smaller but similar compressor provides air for agitating the gasoline during its purification treatment. To insure against any stoppage of the air supply for this service, all four compressors are interconnected and arranged so that they will automatically cut in in case the small machine regularly used for this purpose should stop.



GENERATOR SETS

Power for plant and employee use, together with a surplus that is sold to a public-utility company, is generated by these two identical gas-engine-driven sets. Each consists of a 275-hp. PVG gas engine driving a 175-kw. generator belted to an excitation motor.

A Pioneer Compressor for Liquefying Air

A PHOTOGRAPH of what is believed to have been the first compressor ever built for manufacturing liquid air on a commercial scale is reproduced on this page. The machine was made in the United States; sent to Paris in 1900 for exhibition at the International Universal Exposition; returned to this country; and then sold. Available records do not disclose the name of the purchaser, nor how long the unit ran. It is possible that it is still in service. Air was liquefied in Germany by Carl Linde in 1895 and in England by Hampson in 1896. As early as 1898, Prof. Charles E. Tripler was making liquid air on a laboratory scale in New York and, according to trade papers of that day, he had applied for patents on his process five years earlier.

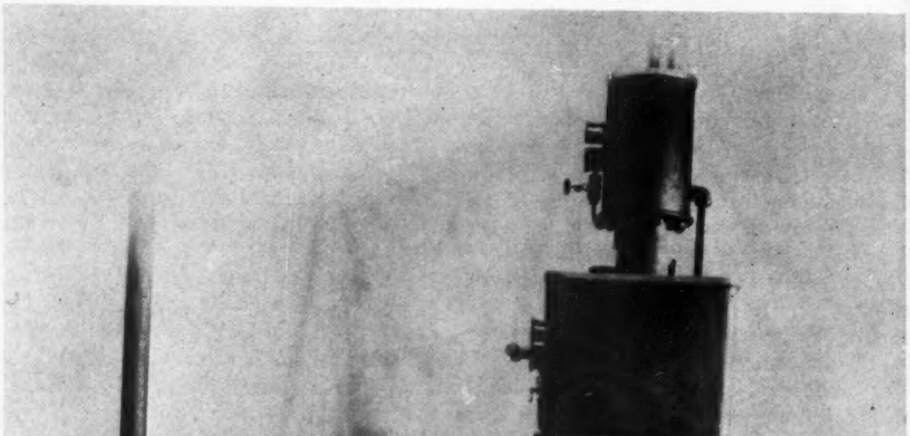
The compressor pictured here was manufactured at Painted Post, N. Y., by the Rand Drill Company, one of the predecessors of Ingersoll-Rand Company. It was steam driven, and had two horizontal power cylinders 11 and 18 inches in diameter and of 10-inch stroke. The compression end was of 3-stage construction, and consisted of vertical cylinders of 10-, 5 3/16-, and 2 5/16-inch diameter and 10-inch stroke. The machine was designed for 2,500 pounds discharge pressure.

At the time the unit was built, liquid air was commanding great attention among engineers and industrialists, and hopes were high that it would prove of great commercial importance. Professor Tripler formed the Tripler Liquid Air Company and displayed complete apparatus for liquefying air at the Paris Exposition. With it, he produced about 5 gallons of liquid air an hour. Various uses of the product were demonstrated, including that of propelling an automobile. The vehicle covered about 50 miles on a charge of 10 gallons of liquid air. After witnessing this and similar demonstrations, engineers were convinced that this form of propulsion was bound to be widely applied. One trade paper commented: "That liquid air moves the automobile is not to be doubted; that it will be of practical use in that field, Professor Tripler said he was certain."

In connection with the liquefying plant there was exhibited a large, butcher's ice box cooled by liquid air, and a small model refrigerating plant. After cooling the ice box, the exhaust air was fed to a rock drill, which was driven by it in the same manner as with ordinary compressed air. The exhaust air from the model refrigerator was conducted to a steam engine which it operated by means of its expansive power. Having previously passed through several long coils of pipe, the air had been warmed to very nearly atmospheric temperature and, consequently, had developed the equivalent of about 5½ horsepower-hours per gallon of liquid air. The engine was employed to drive a dynamo for producing current, and this served to light several electric lamps. The purpose of the plant was to demonstrate just how liquid air could be used for both refrigeration and power in such places as warehouses and hotels. The exhaust from the engine was rich in oxygen, and to illustrate its effectiveness in reducing metals, a bar of steel was put in the exhaust and a lighted taper applied, whereupon it burned fiercely, making a brilliant light and consuming the steel.

In the case of an automobile shown in New York, the liquid air was stored in two 10-gallon copper tanks from which it flowed to an auxiliary tank and then to the engine. About ten minutes was required for the evaporation of enough air to get up the necessary pressure. The car's original gasoline engine was used, and the vehicle was controlled in the ordinary manner. It ran approximately 7 miles on a gallon of liquid air. The intense cold resulting from the evaporation of the liquid caused ice to form on all the pipes through which it flowed and suggested the idea of possibly operating and air conditioning automobiles by the one agency.

Most of the applications envisioned for liquid air in that era failed to materialize, and its principal use in the meantime has been as a medium for producing liquid oxygen by distilling out the nitrogen.



FOR LIQUEFYING AIR

The rapidity with which the American manufacturing industry has always kept up with the advances of science is evidenced by the fact that the Rand Drill Company, makers of this machine, had developed and placed on the market high-pressure compressors for manufacturing liquid air and liquid oxygen within five years after the first successful laboratory experiments were concluded.

CHANNEL TUNNEL AGAIN

FOR many decades a tunnel underneath the British Channel was frowned upon by England because of fear that it might be of help to an invading army from France. During the World War, strangely enough, such a tunnel was advocated on the grounds that it would insure safe transport of troops and munitions to France. After due deliberation, however, the British Government voted against the plan. Now it is being revived, and the most cogent argument in its favor is that of military expediency.

It has been 137 years since a mining engineer named Mathieu first inspired Napoleon Bonaparte with the idea of a transchannel bore. Periodically since then the scheme has grown hot and cold by turns. In 1882 construction was actually started by joint action of companies in England and France, but a commission of parliament members stopped the work in 1883. At the time, shafts had been sunk on both shores and headings had been driven 6,200 feet from the English side and 6,027 feet from the French side. The material was chalk, such as that composing the cliffs at Dover; and a specially designed machine had been able to advance the 7-foot pilot bore as much as sixteen feet in an hour. This is said to be the greatest rate of progress ever made in a subaqueous tunnel.

During the interval since the World War, the tunnel project has been revived several times. In 1924 it came before the British Government and was promptly squelched, owing to the influence of isolationists. But, in 1930, a special governmental committee recommended the construction of a twin-tube tunnel. The report was never acted upon, however. Throughout the years that the project has been under consideration, the French have been willing to coöperate, but the British public mind has never quite reconciled itself to the idea.

A channel tunnel would be around 36 miles long, of which 24 miles would be underwater. The estimated cost is $240,000,000 to $300,000,000. Those who are urging a tunnel now point out that the war is costing England and France approximately $25,000,000 a day at present. They argue that if a tunnel helped shorten the conflict by two weeks it would more than pay for itself.

AIR VERSUS ELECTRICITY

COMPRESSED air is undeniably the most satisfactory kind of power available for certain applications. Electric power is admittedly superior for certain other purposes. There are some fields, however, where either of these forms of power can be used and where opinions differ as to which is the better over-all medium to employ.

In the fabrication of light iron, steel, aluminum and plastic products, large numbers of small tools are used for such operations as light drilling, reaming, screw driving, and nut running. They can be had in either air- or electrically operated types, and a decision as to which type should be employed can be properly made only by considering the advantages of light weight, ease of control, and freedom from electrical hazards of air tools as against the one advantage of lower power cost of electrical tools.

The impression prevails that compressed air is more expensive than electricity. This is perhaps true in a broad sense, but more particularly where large machines are concerned. In the case of small tools, the relative inefficiency of small electric motors brings the cost of operating them close to the range of air-powered tools.

The fact is, however, that the cost of power is negligible as compared with the cost of labor for operating the tools. An efficient small air tool, for example, consumes about 10 cubic feet of air a minute. Assuming a load factor of one-third, which is reasonable for average work, then the air consumption is 200 cubic feet an hour. This costs less than one cent in many plants. That one cent is only about one per cent of the labor cost for operating the tool each hour. It is obvious, then, that if an air-driven tool will save one minute of the operator's time every hour, it will save more than the entire cost of the air required to run it.

The air-tool manufacturers contend that their products will, in many applications, save not just one minute an hour but many minutes, and there is much evidence to support their contention. As compared with high-cycle electric tools, modern air-driven types possess numerous advantages. In the first place, they are 50 to 66 per cent lighter, and are much smaller. Consequently, they fit the hand better and are more convenient and less fatiguing to handle.

Air tools have greater flexibility than electric tools. By controlling the air supply, their speed can be suitably regulated. An air tool can be stalled without damaging it, and consequently requires no clutch. There is no possibility of incurring shocks or burns from air tools.

The cost of maintaining air tools is low, and they are very durable. A tool costing $60 will, under average conditions, run 8,000 to 10,000 hours before it is worn out. During that same period, from $8,000 to $10,000 will, in many plants, have been paid out as wages for operating it.

It is sometimes argued that compressed air is costly because there is so much leakage in the distribution lines. With reasonable care, however, leaks can be averted. Natural gas is transmitted under high pressure from Texas to many northern cities without leakage. Plant air lines are, on an average, only a few hundred feet long and can be kept tight with a small amount of attention.

From the foregoing presentation, it will be apparent that the savings in time made possible by the various advantages of air tools will aggregate many man-hours each day. The resultant monetary savings are so great that comparative costs of compressed air and electric power become a factor of relative insignificance in deciding which type of tool shall be used.

New Applications for Water Glass

WATER glass, in the language of the mineralogist, is a glassy or stony substance consisting of silicates of sodium or potassium, or both. It is soluble in water, forming a viscous liquid, and is put to widely diversified uses in the manufacture of textiles, paper, paint, fireproof materials, adhesives, etc. Latterly, two new applications have been added to the list of practical uses and offer an outlet for large quantities of the substance. It is being employed in the making of soap and for the purpose of solidifying soils that are not sufficiently stable to bear heavy loads such as dams, buildings, or other structures.

In soap making, about 20 per cent of water glass is added to it as a filler and electrolyte. Aside from serving as a substitute for oils and fats, it is said to increase the cleansing power of the soap. By the Joosten process of cementing pervious or yielding foundations, two separate solutions are required—water glass and calcium chloride. These are forced separately into the ground under high pressure and, as a result of the chemical reaction set up between them, cause a silica gel to be liberated that binds the sand or soil into a compact mass. This process is being used extensively in Europe and is increasing the demand for water glass. Similar injections or admixtures of water-glass solutions will impart greater strength to efflorescent building stone, cement mortar, and lime plaster. Furthermore, mixed with lime, magnesia, zinc oxide, or asbestos, they form insoluble silicates that become firm and hard and are excellent as putty.

It should be added in conclusion that water glass of high silicic-acid content has become of considerable importance in the textile industry, particularly in connection with the hydrogen-peroxide bleaches now so essential. According to information from abroad, water glass alkalizes the bleaching liquor and stabilizes or controls the development of oxygen so that rayon and mixed fabrics can be bleached without injury. Sodium and potassium water glass is available in viscous-liquid and powdered form to meet the different needs.

Intricate Molds Made by New Process

BY COVERING objects as fragile and intricate as leaves with a layer of electrically deposited iron, it is possible to make molds in which such objects can be reproduced with fidelity, even to the finest tracery and outlines. The electrodeposition takes about two weeks, and the molds are generally a little more than 1/3 inch thick. This process was developed by the United States Rubber Company primarily for the production of low-cost tire molds, and is known as electroforming.

Armco iron is used, and can be deposited against patterns made of rubber, glass, wood, plastic, and metals, except zinc and aluminum which would be attacked by the plating bath. Patterns with as many as 7,400 lines to a square inch have been reproduced in this fashion. The method has a wide field of application, and, aside from the manufacture of tires, is already being employed in the quantity production of a wide range of plastic, rubber, ceramic, glass, and metal articles, including jewelry and silverware, which, because of their intricate and irregular form, would heretofore have required the use of expensive die sets or molds. The process is available to industry on a contract basis and has been given the trade name of Ekko.

Acme Photo

FEEDING A TREE WITH COMPRESSED AIR

This picture, taken in Westlake Park, Los Angeles, Calif., shows how food and water are forced into the ground to nourish the roots of trees. With the auger drill, in the hands of the man at the right, vertical holes 2 or more feet deep are put down at various locations around the tree. Then the pipe assembly with the funnel-like top is inserted in the hole. Compressed air at 110 pounds pressure is turned on to aerate the soil around the roots, loosening it and enabling the small feeder roots to work their way out farther from the tree base. Water and tree food are introduced at the same time, being distributed through the ground by the air pressure. The food has a cotton-meal and bone-meal base and contains nitrates, phosphates, and potash in varying amounts. The necessary air is furnished by a portable compressor, which is mounted on a truck for easy moving. The work is in charge of Fred W. Roewekamp, chief forester of the Los Angeles Park Department.

Dutch Develop Nickel Ore

NICKEL deposits in the Celebes, Dutch East Indies, are to be developed, according to information from Java. Nineteen mining and smelting concessions have been granted by the Netherlands Government to a subsidiary of the East Borneo Company, Inc., the areas involved aggregating 47,000 acres. The ores are said to consist largely of hydrosilicates resulting from the chemical disintegration and erosion of peridotite formations, and are generally found in fissures or pockets at or close to the surface. The layers range from 29 to 50 feet in thickness, seldom more than that, and can be mined by the open-pit method. This advantage, however, is offset by the fact that large quantities of the ore will have to be transported and smelted because its nickel content, with few exceptions, does not average more than 1 to 2 per cent.

During 1938, approximately 22,000 tons of ore from the Kolaka district were tested with satisfactory results, and it is now proposed to erect smelters at Pamala'a, on Mekongga Bay, which is about 6.2 miles south of the mining area. The latter is to be made accessible by a narrow-gauge railroad. Smelting is to be done by a patented Krupp process in furnaces of the horizontal type; and the plant is to have a total annual output of a little more than 110,200 tons. Each furnace if operated at capacity will require 33,000 tons of coke a year, and this is to be produced from coal from the company's own collieries at Samarinda on the nearby Island of Borneo.

This and That

Taylor-Wharton Stories

A company as old as the Taylor-Wharton Iron & Steel Company is bound to be rich in human-interest items as well as in tradition. Some of the sidelights that came to hand in gathering material for the article that starts on page 6049 are worth setting down here.

In the years immediately following 1892, the company was striving against great obstacles to introduce manganese-steel mine-car wheels in the anthracite coal mines. Cast-iron wheels were in general use, and they did not have a very long life partly because the method of braking them on steep down grades frequently tore out all the spokes. A piece of hard wood, or an iron bar, was thrust between the spokes so as to arrest their turning and to slide them. This practice of "spragging" imposed a severe shock on the wheels that they sometimes couldn't withstand.

Despite their faults, however, cast-iron wheels continued to be favored by the mine managers, none of whom would, for a long time, give manganese-steel wheels a trial. In those days, Percival Chrystie, who later became president of Taylor-Wharton, was attempting to sell car wheels. One day he was in the office of one of the coal companies in Scranton extolling the virtue of his manganese-steel products as he had often done before with negative results. He was stressing their great resistance to breakage, and had one of the wheels in his hands as he talked. Probably hoping to get rid of him, the coal-company manager said: "If your wheel is as strong as you say it is, drop it out the window and let's find out if it will break."

The office was on the top floor of what was then the highest business building in Scranton. Below was a paved street. Chrystie had never attempted such a test before, and his heart was in his mouth as he agreed to the trial. Selecting a moment when no one was passing, he heaved the wheel into space. It landed undamaged: the mine manager was convinced of its superiority and signed an order, the first of many that were to follow. Manganese-steel mine-car wheels became one of the company's leading products, and were used in the Pennsylvania anthracite fields for many years.

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Opportunity, according to one definition, is being in the right place at the right time. For George R. Hanks, who heads the 198-year-old Taylor-Wharton Iron & Steel Company, High Bridge, N. J., was the right place and 1915 was the right time, but baseball must be credited with an assist for his being there. In his undergraduate days at Princeton University, Mr. Hanks played the national pastime, and his contemporaries say he played it well. Upon being graduated, he sought and obtained a job with one of the Taylor-Wharton associate companies in Philadelphia. Word got around that he was a baseball player and, as the company team at High Bridge needed strengthening, he was asked how he would like to go there to work in the foundry for the summer. The arrangement suited him, and he went. But when summer was over, he didn't leave. He remained to work up through the organization, and in 1929 he was elected its president.

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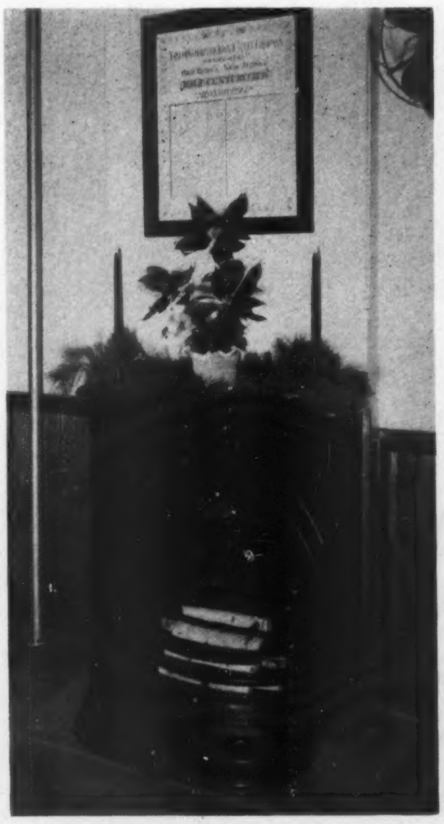
Considerable manganese-steel scrap is mixed together with other constituent metals to form the melt with which castings are poured at the Taylor-Wharton foundry in High Bridge, N.J. This scrap is frequently in pieces too large for the furnaces and must be broken. Manganese-steel that has been heat treated is so tough that it can't be fractured—under sufficient weight it simply batters and crumples like a tin can. Heating it destroys this toughness and renders it brittle, so sizable pieces are first subjected to heat.



OFFICE FIREPLACE

Above this old fireplace in the office building at High Bridge is the roll of the Half-Century Club. It contains the names of 35 men who served Taylor-Wharton 50 years or longer.

Some years ago the company set up equipment in its yard for breaking this scrap. The machinery consists of an overhead traveling crane that lifts a 7,000-pound steel ball with an electromagnet and drops it on the pile of scrap. In the trade it is called a drop ball.

The location of this apparatus is just across the street from a row of houses. An old lady dwelt in one of these houses when the drop ball was first put in service and she evinced great interest in it, making frequent trips to her front porch during the day to watch it perform. She plainly showed that she didn't understand its purpose, however, when she reported to a neighbor that evening:

"Those poor men spent all day tinkering with that new machine, but they couldn't get it to work. Every time they would get that ball almost up, it would drop. They kept at it all day, but they never did get it up to the top."

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In 1881, a water-wheel-driven forge hammer was dismantled at the High Bridge works. From a white-oak foundation timber, an employee, Marshall F. Apgar, split off a piece of wood which he fashioned by hand into a cane. This he presented to L. H. Taylor, then head of the concern. This piece of timber had been a part of the original water-power plant, built in 1742 or earlier.

Mr. Taylor kept and cherished the cane until his death in 1907, when its ownership passed to his grandson, Percival H. Chrystie, who was later to become president of Taylor-Wharton. In 1924, Mr. Chrystie had a gold head made for the cane and directed that it should henceforth become an emblem of honor for the oldest ranking employee, to be held by him as long as he should live. It was presented to Elias Struble at a ceremony attended by company officials. Upon Mr. Struble's death, in 1926, it was presented to David L. Apgar.

In all, five men have held the cane and have had their names engraved upon its head. Last July 3, it passed into the hands of Marshall F. Apgar, the man who had made it 58 years previously. Mr. Apgar entered the employ of the company in 1873, when he was twelve years old. He worked 53 years, and during that period was absent because of illness only once, and then for three weeks. When he retired in 1926 he was plant superintendent. Two of his sons are now in the company's employ. Incidentally, the name Apgar has appeared more often than any other on the rolls of Taylor-Wharton workmen.

Industrial Notes

An alternating-current, adjustable-speed motor based on a new principle has been announced by The Louis Allis Company. It is described as a combination of an eddy-current clutch and a standard constant-speed, alternating-current, squirrel-cage motor. Speed and torque variations are controlled by the magnetic excitation of the clutch, making it possible to obtain any desired slip. Among the claims made for the

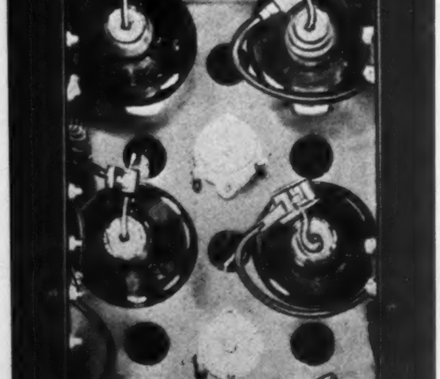
new motor by the manufacturer are: Gradual or quick acceleration of load and rapid intermittent starting and disconnecting of load without jar, shock, or stress on any of the driving parts; absorption of torsional impulses and vibrations; long life because there is no mechanical contact between the driving and the driven members of the unit; exceptional range of speed variation from zero to full speed at full-load torque; and continuous operation at low speeds without overheating. The clutch is available in a wide variety of torque characteristics and in sizes from fractional to several thousand horsepower. Excitation requires comparatively little power and can be effected by remote control. Full information about the Adjusto-Spede motor are contained in an illustrated bulletin, No. 611, which can be obtained from The Louis Allis Company, Milwaukee, Wis.

If you want well-defined X-ray photographs of irregularly shaped metal objects, first pour over and about them copper or steel shot of such minuteness that 10,000,000 of them will have room in a cubic inch of space. The explanation for this, according to C. D. Moriarty of the General Electric Company, is that there is a decided difference in the absorption of X-rays by air and by metals. If the entire negative is not in back of metal, that part of it that is in contact with the air will be overexposed, with the result that the exposure will "spill over" and the picture of the object will have blurred and fuzzy edges.

For the lining and construction of pickling tanks, The Atlas Mineral Products Company has something that it claims is inert both to hot sulphuric and hot lime solutions and resistant to temperatures up to 250°F. A feature of it is that the joints exposed to the acid bath are filled with Korez, a phenol-formaldehyde resin cement that sets by chemical reaction, while those in the back course of bricks are filled with molten Vitrobond, which is a plasticized sulphur-base cement. A recently built 54-inch hot strip mill has pickling tanks with this type of dual lining.

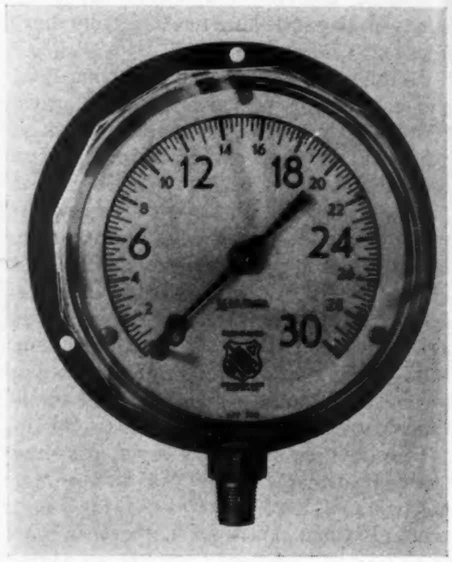
Aluminum wool is now available and is said to have a number of advantages over the familiar steel wool because it is less abrasive and is proof against corrosion. It comes in both fine and coarse grades in the form of long strands, and is suitable for cleaning, filtering, calking, and other purposes.

What is said to be a new product in the electrical field is being offered by the Mellaphone Corporation. It is the Electronic Tube Rectifier developed by that company to meet the need for a convenient and economical source of direct current created as a result of the increasing use of variable-speed, direct-current motors on grinders and lathes. It converts 3-phase, 220-volt alternating current into direct current at 230 volts, and has an output of 10 kw., or approximately 14 hp. Taps are provided for line-voltage adjustments from 210 to 230 volts; and the mercury-vapor tubes used have a guaranteed life of 2,000 hours under full load. According to the manufacturer, the output voltage has very little ripple and remains well-nigh constant regardless of the load. The rectifier has no moving parts to wear out, and no starting



boxes, rheostats, or panel boards—installing being simply a matter of connecting three alternating-current and two direct-current wires to their proper terminals. If required, provision can be made for dynamic braking. The unit measures 13x18½-x24 inches and weighs 210 pounds. It is also suitable for use on magnetic chucks of any size.

Ashcroft 4½- and 6-inch Duragauges are now provided with crystal-clear, nonbreakable covers. They are a product of Manning, Maxwell & Moore, Inc., and are



made of a transparent plastic that is said to have a tensile strength of about 5,000 pounds per square inch and a compressive strength of approximately 15,000 pounds. The Transparent Gauge Cover, as it is designated, threads on to the gauge case and makes it dust- and moistureproof.

Solder in paste form has been put on the market under the name of Meltomatic Paste Solder. It contains the deoxidizing agent or flux, and also dispenses with the familiar soldering iron. Application is effected by brush, and a blow torch or similar apparatus supplies the necessary heat. It is said to make perfect joints without waste of material and at a saving in cost.

Tracings, blueprints, maps, etc., that have to be handled frequently, can be prevented from tearing by binding their edges. Two machines have recently been devised for this purpose, and they are said to do the work quickly and neatly without the use of heat or water. Each has a reel carrying renewable rolls of tape and is operated by a hand crank.

Apexior is the name of a new protective coating for the internal surfaces of boilers, economizers, and steam plants generally. It is claimed to improve heat transference and to prevent the formation of iron oxide and discoloration of the water. The compound is applied by what is known as a Powercoater, a compressed-air and electrically operated apparatus that both injects the material into the tubes and spreads it on to the surfaces. This is done

at the time of the routine boiler cleaning and overhaul. It takes less than one minute, it is said, to treat each tube. The Powercoater is rotated by means of the tube cleaner, and bristle brushes attached to the former and expanded by centrifugal force cover the walls uniformly with the compound and press it into the pores of the metal. The brush units come in a number of types and sizes suitable for standard boiler tubes and are designed to adapt themselves to any tube curvature or irregularity. The coater and coating are the products of J. Dampney & Company, Ltd., Newcastle-upon-Tyne, England.

Collapsible rubber boats as lifesavers have proved their effectiveness during the present conflict, it is reported from abroad. Survivors of raiding bombers brought down off the English coast have on several occasions been kept afloat by them, and in one case for as long as three days.

A new process has been developed in Australia for the production of tungsten oxide and tungsten powder from wolframite and scheelite. It is the invention of A. W. Dye, and is being used in a plant erected for the purpose in Sydney. Small quantities of bismuth, arsenic, and tin are obtained as by-products. The process is said to be a secret one and to be more economical than the methods of refining now in general use in Germany, England, and the United States.

Copper-bearing cement is a new product for structural purposes and is said to be superior to portland cement in a number of particulars. By mixing finely divided copper incorporated with caustic magnesium in a solution of magnesium chloride, a synthetic mineral is formed in the mix that is resistant to weathering. It is further claimed that the cement will take any kind of filler or aggregate and that it can be sprayed, brushed, or troweled on to any building material.

New York City is trying out a new traffic marker along a short stretch of its much-traversed West Side elevated express highway. It is a 3-piece unit, and consists of a Rawl expansion anchor which is inserted in a hole drilled in the paving, of an aluminum-alloy reflector, and of a machine screw which holds the marker in the socket. The screw is made of Monel metal which, because of its inherent properties, will prevent it from freezing or breaking in the anchor, thus permitting the reflectors to be easily renewed. They are spaced at 15-foot intervals and cost 50 cents each, including installation. As compared with painted stripes, and assuming that the new markers have a service life of five to ten years, as claimed, they would bring about a saving per mile of highway in those intervals of as much as $300 and $800, respectively.